



**SAJOUS'S**  
**ANALYTIC CYCLOPEDIA**  
**OF**  
**PRACTICAL MEDICINE**

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# CONTENTS OF FIFTH VOLUME

	PAGE		PAGE
Gas, Poisoning by (Coal or Illuminating Gas) .....	1	Glaucoma ( <i>continued</i> ) .....	
Illuminating Gas .....	1	Etiology .....	25
Symptoms .....	2	Varieties .....	26
Acute Poisoning .....	2	Prognosis .....	26
Automobile Gas Poisoning .....	3	Treatment .....	26
After-effects .....	3	Glucose .....	28
Chronic Poisoning .....	5	Modes of Administration and Dose ...	28
Treatment .....	6	Therapeutic Uses .....	28
Coal Gas from Stoves, Furnaces, etc., Poisoning by .....	9	Glycemia .....	29
Gas of Warfare .....	9	Children .....	29
Symptoms .....	9	Blood-sugar Tests .....	29
Pathology .....	10	Clinical Applications .....	29
Prophylaxis .....	10	Glycerin .....	29
Treatment .....	10	Preparations and Doses .....	30
Gaultheria .....	11	Physiological Action .....	30
Preparations and Dose .....	11	Therapeutics .....	30
Physiological Action .....	11	Constipation .....	30
Poisoning by Gaultheria .....	12	Genitourinary Disorders .....	31
Treatment of Poisoning by Gaultheria .....	12	Inflammatory and Septic Surgical Disorders .....	31
Therapeutics .....	12	Glycosuria .....	33
Gavage .....	12	Definition .....	33
Technique .....	12	Symptoms .....	33
Gelatin .....	13	Etiology .....	34
Preparations and Dose .....	13	Treatment .....	38
Physiological Action .....	14	Goiter, or Struma; Bronchocele .....	39
Therapeutics .....	15	Etiology .....	39
Gelsemium .....	16	Goiter due to Inherent Defensive Insufficiency of the Thyroid Apparatus .....	44
Preparations and Dose .....	16	Non-toxic Diffuse Colloid Goiter .....	49
Physiological Action .....	17	Symptoms .....	49
Poisoning by Gelsemium .....	17	Diagnosis .....	50
Therapeutics .....	18	Prognosis .....	50
Cerebral Disorders .....	18	Pathology .....	50
Spasmodic Disorders .....	18	Treatment .....	50
Neuralgia .....	18	Toxic Adenomatous Goiter .....	53
Fevers .....	18	Symptoms .....	54
Skin Disorders .....	18	Diagnosis .....	57
Mydriasis .....	19	Etiology .....	58
General Paralysis, or Paresis. See Mental Diseases.		Pathology .....	59
Gentian .....	19	Treatment .....	60
Preparations and Doses .....	19	Nodular or Lobulated Goiters .....	67
Physiological Action .....	19	Obstructive and Pressure Symptoms ..	68
Therapeutics .....	19	Treatment .....	70
Genu Valgum and Varum. See Orthopedic Surgery.		Fibrous or Ligneous Goiter. Riedel's Disease .....	70
German Measles. See Rubella.		Aberrant Goiters .....	71
Gestation, Ectopic. See Pregnancy.		Treatment .....	71
Ginger Inebriety. See Zingiberis.		Malignant Goiter .....	71
Glanders, or Farcy .....	19	Treatment .....	73
Definition .....	19	Congenital Goiter, or Goiter in the Newborn .....	73
Symptoms .....	19	Symptoms .....	74
Diagnosis .....	21	Prognosis .....	74
Treatment .....	23	Treatment .....	75
Glaucoma .....	24	Thyroiditis .....	75
Symptoms .....	24	Symptoms .....	76
Diagnosis .....	25	Diagnosis .....	77

	PAGE		PAGE
Goiter, or Struma; Bronchocele, Thyroid- itis ( <i>continued</i> ) . . . . .		Graves's Disease, Exophthalmic Goiter, Diagnosis ( <i>continued</i> ) . . . . .	
Prognosis . . . . .	77	Diagnostic Tests . . . . .	125
Treatment . . . . .	77	Etiology . . . . .	127
Acute Strumitis . . . . .	78	Primary Cause . . . . .	129
Symptoms . . . . .	78	Pathology . . . . .	130
Diagnosis . . . . .	79	Prognosis . . . . .	132
Prognosis . . . . .	79	Treatment . . . . .	134
Treatment . . . . .	79	Grindelia . . . . .	142
Prevention of Goiter . . . . .	79	Preparations and Doses . . . . .	142
Gold . . . . .	80	Physiological Action . . . . .	142
Physiological Action . . . . .	80	Therapeutics . . . . .	142
Poisoning by Gold . . . . .	81	Guaiac . . . . .	143
Treatment of Acute Poisoning by Gold . . . . .	81	Preparations and Doses . . . . .	143
Therapeutics . . . . .	81	Physiological Action . . . . .	143
Gonorrhea. See Urinary and Genital Systems, Surgical Diseases of.		Therapeutics . . . . .	143
Gonorrheal Arthritis. See Rheumatism, Gonorrheal.		Guaiacal . . . . .	143
Gonorrheal Ophthalmia. See Conjunc- tiva, Diseases of.		Preparations and Doses . . . . .	144
Gonorrheal Rheumatism. See Rheuma- tism.		Physiological Action . . . . .	144
Gonorrheal Vaginitis. See Vagina and Vulva, Diseases of.		Poisoning by Guaiacol . . . . .	144
Goundou (Anakhre, Henpue, Big-nose). . . . .	82	Treatment of Guaiacol Poisoning . . . . .	145
Etiology and Pathology . . . . .	82	Therapeutics . . . . .	145
Treatment . . . . .	82	Guarana . . . . .	149
Gout . . . . .	82	Preparations and Doses . . . . .	149
Synonyms . . . . .	82	Physiological Action . . . . .	149
Definition . . . . .	82	Therapeutics . . . . .	149
Symptoms . . . . .	82	Guinea-worm Disease. See Parasites, Diseases Due to.	
Chronic Gout . . . . .	85	Gunshot Wounds of Abdomen. See Ab- dominal Injuries.	
Irregular Gout . . . . .	85	Gunshot Wounds of Brain. See Head and Brain, Diseases of.	
Diagnosis . . . . .	88	Gunshot Wounds of Head. See Head and Brain, Diseases of.	
Etiology and Pathogeny . . . . .	90	Gunshot Wounds of Stomach. See Ab- dominal Injuries.	
Pathology . . . . .	97	Gypsum. See Calcium.	
Prognosis . . . . .	100		
Treatment . . . . .	100	Hair, Diseases of the . . . . .	149
Dietetic Treatment . . . . .	101	Atrophy of the Hair . . . . .	149
Treatment of Hereditary Gout . . . . .	103	Physiological Atrophy . . . . .	149
Treatment of the Acute Attack . . . . .	104	Pathological Atrophy . . . . .	149
Mineral Springs . . . . .	108	Fragility of the Hair . . . . .	150
Medicinal and Other Measures . . . . .	109	Moniliform Hair . . . . .	150
Internal or Retrocedent Gout . . . . .	111	Etiology . . . . .	150
Granuloma Coccidioides . . . . .	112	Treatment . . . . .	150
Symptoms and Pathology . . . . .	112	Canities . . . . .	151
Treatment . . . . .	112	Synonyms . . . . .	151
Granuloma Inguinale . . . . .	112	Etiology . . . . .	151
Symptoms . . . . .	112	Prognosis . . . . .	151
Etiology . . . . .	113	Treatment . . . . .	151
Treatment . . . . .	113	Hypertrophy of the Hair . . . . .	152
Graves's Disease, Exophthalmic Goiter, Basedow's Disease . . . . .	113	Synonyms . . . . .	152
Definition . . . . .	113	Partial Congenital Hypertrichosis . . . . .	152
Symptoms . . . . .	113	General Congenital Hypertrichosis . . . . .	153
Swelling of the Thyroid . . . . .	113	Acquired Hypertrichosis . . . . .	153
Nervous Symptoms . . . . .	114	Partial Acquired Hypertrichosis . . . . .	153
Mental Phenomena . . . . .	115	Etiology . . . . .	153
Circulatory Symptoms . . . . .	115	Prognosis . . . . .	154
The Eyes . . . . .	117	Treatment . . . . .	154
The Gastro-intestinal Tract . . . . .	119	Epilation . . . . .	154
Cutaneous Symptoms . . . . .	119	Shaving, Cutting, and Singeing . . . . .	154
Respiratory Symptoms . . . . .	121	Depilatories . . . . .	154
Genito-urinary Phenomena . . . . .	121	Hydrogen Dioxide . . . . .	154
Miscellaneous Symptoms . . . . .	123	Pumice-stone . . . . .	155
Diagnosis . . . . .	124	Electrolysis . . . . .	155
		X-rays . . . . .	156

	PAGE		PAGE
Hair, Diseases of the ( <i>continued</i> ).		Head and Brain, Diseases of, Diseases of	
Disorders of Secretion See Sebor-		the Skull ( <i>continued</i> ).	
rhea Sicca (Dandruff).		Atrophy of the Bones of the Skull .	173
Sycosis Non-parasitica . . . . .	156	Tumors of the Skull . . . . .	174
Synonyms . . . . .	156	Surgery of the Brain . . . . .	175
Treatment . . . . .	156	Cerebral Localization . . . . .	175
External or Local Treatment . . . .	157	Technique of Intracranial Surgery .	175
Parasitic Disorders . . . . .	158	Intracranial Hypertension . . . . .	184
Tinea Favosa . . . . .	158	Surgery of the Lateral Ventricles .	185
Synonyms . . . . .	158	Ventriculography . . . . .	185
Treatment . . . . .	158	Puncture of Corpus Callosum . . .	186
Tinea Trichophytina . . . . .	159	Cerebral Concussion . . . . .	186
Synonyms . . . . .	159	Symptoms . . . . .	186
Treatment . . . . .	159	Prognosis . . . . .	187
Pediculosis . . . . .	160	Treatment . . . . .	187
Synonyms . . . . .	160	Cerebral Contusion and Laceration .	187
Treatment . . . . .	160	Symptoms . . . . .	187
Neurotic Disorders . . . . .	160	Pathology . . . . .	188
Trichopathophobia . . . . .	160	Prognosis . . . . .	189
Voluntary Erection of the Hair . . .	160	Treatment . . . . .	189
Hamamelis . . . . .	161	Subdural Hemorrhage . . . . .	190
Preparations and Doses . . . . .	161	Symptoms . . . . .	190
Therapeutics . . . . .	161	Etiology . . . . .	190
Hammer Toe. See Orthopedic Surgery.		Pathology . . . . .	190
Hand, Club-. See Orthopedic Surgery.		Treatment . . . . .	190
Hanot's Cirrhosis. See Cirrhosis of the		Cerebral Hemorrhage. See Cerebral	
Liver.		Hemorrhage.	
Harelip. See Surgical Anaplasty.		Compression of the Brain . . . . .	190
Hashish. See Cannabis.		Treatment . . . . .	191
Hay Fever. See Hyperesthetic Rhinitis.		Traumatic Intracranial Hemorrhage .	191
Head and Brain, Diseases of . . . . .	162	Extradural Hemorrhage . . . . .	192
Diseases of the Scalp . . . . .	162	Symptoms . . . . .	192
Contusions . . . . .	162	Diagnosis . . . . .	192
Treatment . . . . .	162	Etiology . . . . .	192
Wounds of the Scalp . . . . .	163	Pathology . . . . .	193
Treatment . . . . .	163	Prognosis . . . . .	193
Traumatic or Spurious Meningocele .	164	Treatment . . . . .	193
Abscess of the Scalp . . . . .	164	Abscess of Cerebrum and Cerebellum.	
Treatment . . . . .	164	See Cerebral Abscess.	
Caput Succedaneum . . . . .	164	Infective Sinus Thrombosis . . . . .	194
Tumors . . . . .	165	Symptoms . . . . .	194
Sebaceous Tumor, or Wen . . . . .	165	Treatment . . . . .	194
Treatment . . . . .	165	Wounds of the Sinuses of the Brain .	195
Horns . . . . .	165	Inflammation of the Brain and Menin-	
Warts and Moles . . . . .	165	ges . . . . .	195
Fatty Tumors . . . . .	165	Pachymeningitis Externa . . . . .	195
Congenital Cysts, Fibromata . . . .	165	Pachymeningitis Interna . . . . .	195
Vascular Growths . . . . .	165	Leptomeningitis . . . . .	196
Diseases of the Skull . . . . .	166	Foreign Bodies in the Brain . . . .	196
Penetrating Wounds of the Skull		Tumors of the Brain . . . . .	197
and Brain . . . . .	166	Symptoms . . . . .	197
Symptoms and Diagnosis . . . . .	166	Diagnosis . . . . .	200
Prognosis . . . . .	167	Tumors of Frontal Lobe . . . . .	203
Treatment . . . . .	167	Tumors in the Rolandic, or so-	
Gunshot Wounds of the Head . . . .	168	called Motor, Region . . . . .	204
Treatment . . . . .	169	Tumors of the Parietal Region . .	204
Fungus, or Hernia, Cerebri . . . . .	171	Tumors of the Occipital Lobe . . .	204
Treatment . . . . .	172	Tumors of the Temporosphenoidal	
Pneumatocoele . . . . .	172	Lobe . . . . .	205
Microcephalus . . . . .	172	Tumors of the Corpus Callosum .	205
Inflammation, Periostitis, Osteitis,		Tumors of the Great Ganglia . . .	205
Caries, and Necrosis . . . . .	172	Tumors of the Corpora Quad-	
Symptoms . . . . .	172	rigemina . . . . .	206
Etiology . . . . .	173	Tumors of the Crus . . . . .	206
Prognosis . . . . .	173	Tumors of the Pons . . . . .	206
Treatment . . . . .	173	Tumors of the Cerebellopontile	
Hypertrophy of the Bones of the		Angle . . . . .	207
Skull . . . . .	173	Tumors of the Medulla . . . . .	207

	PAGE		PAGE
Head and Brain, Diseases of, Tumors of the Brain, Diagnosis ( <i>continued</i> ).		Heart and Pericardium, Diseases of the, Myocarditis ( <i>continued</i> ).	
Tumors of the Cerebellum .....	207	II. Chronic Myocarditis .....	255
Tumors of the Base .....	209	Symptoms and Diagnosis .....	255
X-ray Examination .....	209	Etiology .....	256b
Ventriculography .....	209	Pathology .....	256c
Ventricular Estimation .....	209	Prognosis .....	256e
Multiple Tumors .....	209	Treatment .....	256f
Etiology .....	210	Hypertrophy of the Heart .....	256h
Predisposing Causes .....	210	Definition .....	256h
Sex .....	210	Varieties .....	256h
Heredity .....	210	Symptoms .....	257
Exciting Causes .....	210	Differential Diagnosis .....	258
Pathology .....	211	Etiology .....	258
Prognosis .....	212	Pathology .....	260
Treatment .....	213	Prognosis .....	261
Hydrocephalus .....	215	Treatment .....	261
Definition .....	215	Dilatation of the Heart .....	262
Varieties .....	216	Definition .....	262
I. Acute Hydrocephalus .....	216	Varieties .....	262
Definition .....	216	Symptoms .....	262
Symptoms .....	216	Diagnosis .....	265
Etiology .....	218	Etiology .....	267
Pathology .....	220	Prognosis .....	269
Diagnosis .....	221	Treatment .....	271
Prognosis .....	222	Pericardium, Diseases of the .....	275
Treatment .....	222	Pericarditis .....	275
II. Chronic Hydrocephalus .....	224	Definition .....	275
Definition .....	224	Symptoms .....	275
Varieties .....	224	Diagnosis .....	279
Symptoms .....	224	Etiology .....	281
Etiology .....	225	Pathology .....	281
Pathology .....	226	Prognosis .....	282
Prognosis .....	227	Treatment .....	282
Diagnosis .....	227	Chronic Adhesive Pericarditis (Ex-	
Treatment .....	227	ternal Pericarditis; Pleuro-	
Heart and Pericardium, Diseases of the.	228	pericarditis; Mediastinoperi-	
Irregularity of the Heart Beat .....	228	carditis) .....	285
Sinus Irregularity .....	229	Diagnosis .....	285
Premature Systoles .....	230	Pick's Disease .....	286
Treatment .....	231	Treatment .....	286
Auricular Fibrillation .....	231	Hydropericardium .....	288
Etiology .....	232	Hemopericardium .....	288
Pathology .....	232	Pneumopericardium .....	288
Diagnosis .....	233	Treatment .....	289
Prognosis .....	233	Heart, Degenerative Disorders of the ..	289
Treatment .....	234	Definition .....	289
Auricular Flutter .....	239	Fatty Degeneration .....	289
Diagnosis .....	239	Definition .....	289
Prognosis .....	240	Symptoms .....	289
Treatment .....	240	Diagnosis .....	291
Heart Block .....	241	Etiology .....	293
Symptoms .....	241	Pathology .....	294
Adams-Stokes Syndrome .....	242	Prognosis .....	296
Etiology .....	242	Treatment .....	296
Pathology .....	243	Fatty Overgrowth .....	298
Diagnosis .....	243	Definition .....	298
Prognosis .....	247	Symptoms .....	298
Treatment .....	248	Differential Diagnosis .....	300
Pulsus Alternans .....	249	Etiology .....	300
Treatment .....	250	Pathology .....	300
Myocarditis .....	251	Prognosis .....	301
Definition .....	251	Treatment .....	301
I. Acute Myocarditis .....	251	Prophylaxis .....	301
Symptoms and Diagnosis .....	251	Treatment of Fatty Overgrowth ..	302
Etiology .....	252	Rupture of the Heart .....	303
Pathology .....	252	Symptoms .....	303
Treatment .....	253	Diagnosis .....	303

	PAGE		PAGE
Heart, Degenerative Disorders of the,		Heart, Uncommon Disorders of the, Con-	
Rupture of the Heart ( <i>continued</i> ).		genital Heart Affections, Varieties	
Etiology .....	303	( <i>continued</i> ).	
Pathology .....	304	Patulous Foramen Ovale .....	352
Prognosis .....	304	Defective Interventricular Septum .	353
Treatment .....	304	Persistent Ductus Arteriosus ....	353
Brown Atrophy of the Heart .....	304	Valvular Defects .....	353
Calcareous Degeneration or Calcifica-		Symptoms .....	354
tion of the Heart .....	304	Treatment .....	354
Amyloid Degeneration .....	305	Heat Exhaustion and Thermic Fever ...	355
Hyaline Degeneration .....	305	Heat Exhaustion .....	355
Heart, Graphic Methods in the Examina-		Symptoms .....	355
tion of the .....	305	Diagnosis .....	355
Polygraphy .....	305	Etiology and Pathogenesis .....	355
Electrography and Electrocardiograms .	318	Pathology .....	356
Clinical Scope of Electrocardiography	323	Prophylaxis .....	357
The Normal Electrocardiogram .....	323	Treatment .....	357
Ventricular Preponderance .....	325	Thermic Fever .....	357
Cardiac Arrhythmias .....	325	Symptoms .....	357
Sinus Arrhythmia .....	325	Etiology .....	359
Premature Contractions or Extra-		Pathology .....	360
systoles .....	326	Prognosis .....	362
The Frequent Pulse .....	327	Prophylaxis .....	362
Simple Tachycardia .....	327	Treatment .....	362
Paroxysmal Tachycardia .....	328	Hematology and Serum Reactions .....	367
Auricular Flutter .....	329	Methods of Obtaining a Specimen for	
Auricular Fibrillation .....	330	Examination .....	368
Ventricular Fibrillation .....	332	Color .....	368
The Infrequent Pulse .....	332	Taste .....	368
Heart Block .....	335	Odor .....	368
Branch Bundle Block .....	338	Reaction .....	368
Arborization Block .....	339	Alkali Reserve and Acid-base Equi-	
Sino-auricular Block .....	339	librium .....	368
Pulsus Alternans .....	340	Alkali Reserve Determination .....	369
Heart, Functional Tests of, and Other		Specific Gravity .....	369
Diagnostic Procedures .....	341	Hammerschlag's Method of Deter-	
Functional Tests .....	341	mining the Specific Gravity .....	369
Vital Capacity .....	343	Estimation of the Percentage of	
Roentgen Ray Examinations .....	343	Hemoglobin .....	370
Orthodiagraphy .....	343	Tallqvist's Method .....	370
Teleroentgenography .....	343	Gower's Method .....	370
Heart, Palpitation of the .....	344	Sahl's Method .....	370
Symptoms .....	344	Fleischl's Hemoglobinometer .....	370
Diagnosis .....	345	Color-index .....	373
Etiology .....	345	Total Volume of the Blood .....	373
Treatment .....	345	Coagulation of the Blood. See Coagu-	
Heart, Irritable .....	346	lation Time of the Blood.	
Symptoms .....	346	Estimation of the Corpuscles .....	373
Irritable Heart in Recruits .....	346	Diluting Fluids .....	373
Etiology .....	347	Technique .....	374
Treatment .....	347	Counting of the Erythrocytes .....	374
Heart, Uncommon Disorders of the .....	348	Calculation .....	375
Tumors of the Heart .....	348	Counting of Leucocytes .....	375
Symptoms .....	348	Differential Blood-count .....	376
Treatment .....	349	Method of Fixation .....	377
Parasites of the Heart .....	349	Methods of Staining .....	377
Symptoms .....	349	Eosin and Methylene-blue Stain .....	377
Treatment .....	349	Technique .....	377
Aneurism of the Heart .....	349	Eosin-hematoxylin Stain .....	377
Symptoms .....	349	Technique .....	378
Treatment .....	350	Wright's Stain .....	378
Movable, Mobile, or Wandering Heart	351	Technique .....	378
Symptoms .....	351	Effects .....	379
Etiology .....	351	Giemsa's Stain .....	379
Treatment .....	351	Technique .....	379
Dextrocardia .....	352	Effects .....	379
Congenital Heart Affections .....	352	Ehrlich's Triple Stain .....	379
Varieties .....	352	Technique .....	379



	PAGE		PAGE
Hematology and Serum Reactions, Differential Blood-count, Ehrlich's Triple Stain ( <i>continued</i> ) . . . . .		Hematuria, Symptoms, Tests ( <i>continued</i> ) . . . . .	
Effects . . . . .	379	The Guaiac Test (Almén-Schönbein) . . . . .	395
Romanowsky's Polychrome Methylene-blue Stains . . . . .	379	The Benzidin Test (Schumm) . . . . .	395
Jenner's Stain . . . . .	379	Florence Test (for spermatic fluid) . . . . .	395
Technique . . . . .	380	The Hemin Test (Teichmann) . . . . .	395
Effects . . . . .	380	Spectral Analysis . . . . .	395
Leishman's Stain . . . . .	380	Microscopic Examination . . . . .	395
Technique . . . . .	380	Etiology . . . . .	396
Effects . . . . .	380	Diagnosis . . . . .	399
Examination of Blood-smears . . . . .	380	Urethral . . . . .	399
Technique . . . . .	380	Vesical . . . . .	399
Differential Leucocytic Count . . . . .	380	Renal and Ureteral . . . . .	399
Polynuclear Leucocytes . . . . .	380	Prognosis . . . . .	400
Lymphocytes . . . . .	380	Treatment . . . . .	401
Large Mononuclear Leucocytes . . . . .	380	Hemochromatosis . . . . .	402
Eosinophiles . . . . .	381	Hemoclasia . . . . .	403
Myelocytes . . . . .	381	Hemoglobinuria . . . . .	403
Mast Cells . . . . .	381	Definition . . . . .	403
Leucocytosis . . . . .	381	Symptoms . . . . .	403
Leucopenia . . . . .	381	Etiology . . . . .	404
Variations of Volume . . . . .	381	Pathology . . . . .	405
Erythrocytes in a Stained Specimen . . . . .	381	Urine . . . . .	405
Blood-picture in Different Diseases . . . . .	382	Blood . . . . .	406
Arneth's Classification of the Leucocytes . . . . .	384	Diagnosis . . . . .	410
Resisting Power of the Erythrocytes . . . . .	384	Prognosis . . . . .	411
Blood Sedimentation Test . . . . .	384	Treatment . . . . .	411
Blood Platelets . . . . .	385	Hemopericardium. See Heart and Pericardium, Diseases of. . . . .	
Viscosity of the Blood . . . . .	386	Hemophilia . . . . .	412
Factors Influencing Viscosity . . . . .	386	Definition . . . . .	412
Blood Chemistry . . . . .	387	Symptoms . . . . .	412
Nitrogenous Compounds . . . . .	387	Hereditary Hemorrhagic Thrombasthenia . . . . .	413
Blood Urea Determination . . . . .	387	Etiology and Pathogenesis . . . . .	415
Total Nitrogen and Non-Protein Nitrogen Determinations . . . . .	387	Pathology . . . . .	417
Uric Acid . . . . .	388	Prognosis . . . . .	417
Chlorides . . . . .	388	Treatment . . . . .	418
Cholesterol . . . . .	388	Hemoptysis. See Lungs, Diseases of. . . . .	
Sugar. See under Diabetes Mellitus. . . . .		Hemorrhage. See various conditions in which it occurs. . . . .	
Opsonins and Opsonic Index . . . . .	388	Hemorrhagic Disorders of the Newborn. See Newborn, Disorders of, and Adrenal Hemorrhage. . . . .	
Serum Reactions . . . . .	389	Hemorrhoids . . . . .	424
The Widal Test . . . . .	389	Embryology . . . . .	425
Technique . . . . .	389	External Hemorrhoids . . . . .	427
Occurrence of the Reaction . . . . .	390	Treatment of External Hemorrhoids . . . . .	431
The Wassermann Reaction . . . . .	390	Internal Hemorrhoids . . . . .	435
Hemolysis . . . . .	390	Treatment of Internal Hemorrhoids . . . . .	439
Blood-corpusele Emulsion . . . . .	390	Operative Treatment . . . . .	441
Absorption of Complement . . . . .	390	Henbane. See Hyoscyamus. . . . .	
Antigen . . . . .	391	Henpue. See Goundou. . . . .	
Technique of the Reaction . . . . .	391	Hereditary Ataxia. See Spinal Cord, Diseases of. . . . .	
The Abderhalden Test . . . . .	392	Hernia . . . . .	449
Hematoporphyrinuria . . . . .	393	Definition . . . . .	449
Definition . . . . .	393	Varieties . . . . .	449
Symptoms . . . . .	393	Surgical Anatomy . . . . .	450
Etiology . . . . .	393	Etiology . . . . .	451
Treatment . . . . .	394	Reducible Hernia . . . . .	454
Hematoxylin . . . . .	394	Diagnosis . . . . .	454
Preparation and Dose . . . . .	394	Treatment . . . . .	455
Physiological Action . . . . .	394	Trusses . . . . .	455
Therapeutics . . . . .	394	Irreducible Hernia . . . . .	457
Hematuria . . . . .	394	Treatment . . . . .	457
Definition . . . . .	394		
Symptoms . . . . .	394		
Tests . . . . .	394		
Heller's Test . . . . .	394		

	PAGE		PAGE
Hernia ( <i>continued</i> ).		Herpes Zoster and Herpes ( <i>continued</i> ).	
Strangulated Hernia .....	458	Herpes Facialis (Fever-blisters) .....	512
Symptoms .....	459	Etiology .....	512
Diagnosis .....	460	Pathology .....	514
Hydrocele of the Cord .....	461	Prognosis .....	514
Treatment .....	461	Treatment .....	515
Taxis .....	461	Herpes Genitalis .....	516
Operation .....	464	Symptoms .....	516
Intestinal Resection .....	467	Diagnosis .....	517
Indications and Contraindications for		Etiology .....	518
the Radical Operation .....	468	Prognosis .....	518
Children .....	468	Treatment .....	518
Adults .....	468	Heterochylia. See Stomach, Diseases of.	
Contraindications .....	469	Hexamethylenamine (Methenamine) ...	519
Inguinal Hernia .....	469	Preparations and Dose .....	520
Radical Operation .....	469	Modes of Administration .....	520
Results of Operation .....	474	Contraindications .....	520
Dangers and Complications of Radi-		Physiological Action .....	521
cal Operation .....	476	Untoward Effects .....	521
Precautions .....	476	Therapeutic Uses .....	526
Complications .....	478	Hexylresorcinol .....	532
Inguinal Hernia in the Female .....	479	Administration .....	532
Operative Treatment .....	480	Physiological Action .....	532
Femoral Hernia .....	481	Therapeutics .....	532
Diagnosis .....	481	Hiccough (Singultus, Hiccup) .....	532
Treatment .....	482	Etiology and Pathogenesis .....	533
Reducible .....	482	Treatment .....	534
Strangulated .....	482	Epidemic Hiccough .....	536
Radical Operation .....	482	Treatment .....	537
Umbilical Hernia .....	484	Holocaine .....	537
Varieties .....	484	Physiological Action .....	537
Congenital .....	485	Therapeutics .....	537
Treatment .....	485	Homatropine .....	538
Infantile .....	486	Preparations and Dose .....	538
Treatment .....	486	Physiological Action .....	538
Adult .....	487	Poisoning by Homatropine .....	538
Treatment .....	487	Treatment of Poisoning by Homat-	
Ventral Hernia .....	489	ropine .....	539
Epigastric Hernia .....	491	Therapeutics .....	540
Cecal Hernia .....	491	Hydrastis .....	541
Rare Forms of Hernia .....	492	Preparations and Dose .....	541
Diaphragmatic Hernia .....	492	Modes of Administration .....	542
Peritoneal, or Interstitial, Hernia .....	495	Physiological Action .....	543
Lumbar Hernia .....	495	Contraindications .....	544
Hernia into the Foramen of Win-		Poisoning .....	545
slow .....	496	Therapeutics .....	545
Ischiatic Hernia .....	496	Hydroa. See Dermatitis (Dermatitis	
Perineal Hernia .....	496	Herpetiformis).	
Obturator Hernia .....	497	Hydrocele. See Penis and Testicles,	
Retroperitoneal Hernia .....	498	Diseases and Injuries of.	
Herpes Zoster and Herpes .....	498	Hydrocephalus. See Head and Brain,	
Herpes Zoster (Shingles; Zona) .....	498	Surgical Disorders of.	
Definition .....	498	Hydrochloric Acid .....	548
Symptoms .....	499	Physiological Action .....	549
Acute Specific or Spontaneous Zos-		Preparations and Dose .....	549
ter .....	500	Modes of Administration .....	550
Regional Zoster .....	502	Incompatibilities .....	550
Zoster Atypicus Gangrænosus et		Contraindications .....	550
Hystericus .....	503	Poisoning .....	551
Diagnosis .....	504	Treatment of Poisoning .....	553
Etiology .....	504	Therapeutics .....	555
Pathology .....	505	Hydrocyanic Acid .....	557
Prognosis .....	507	Preparations and Dose .....	558
Treatment .....	507	Physiological Action .....	559
Herpes (Herpes Febrilis) .....	510	Untoward Effects and Poisoning .....	560
Definition .....	510	Treatment .....	562
Symptoms .....	510	Hydrogen Dioxide .....	565
Diagnosis .....	512	Preparations and Dose .....	565

	PAGE		PAGE
Hydrogen Dioxide ( <i>continued</i> ).		Hysteria, Symptoms ( <i>continued</i> ).	
Physiological Action .....	566	Sensory Symptoms .....	613
Therapeutics .....	568	Motor Symptoms .....	616
Hydrogen Ion Concentration .....	573	Disorders of the Special Senses .....	619
Blood .....	573	Visceral Symptoms .....	621
Urine .....	574	Miscellaneous Somatic Symptoms ..	622
Hydronephrosis See Kidneys, Diseases		Psychic Symptoms .....	623
of.		Diagnosis .....	627
Hydrophobia. See Rabies.		Prognosis .....	627
Hydropneumothorax. See Pleura, Dis-		Treatment .....	628
eases of.			
Hydrotherapy. See Water.		Ichthyol .....	633
Hyoscine. See Scopol and Scopolamine.		Preparations and Dose .....	634
Hyoscyamus .....	575	Physiological Action .....	634
Preparations and Dose .....	576	Untoward Action of Ichthyol .....	634
Physiological Action .....	577	Therapeutics .....	635
Poisoning .....	578	Ichthyosis .....	640
Treatment of Poisoning .....	578	Synonyms .....	641
Therapeutics .....	578	Varieties .....	641
Hyperchlorhydria. See Stomach, Dis-		Symptoms .....	641
eases of: Hyperacidity.		Ichthyosis Simplex .....	641
Hyperchylia. See Stomach, Diseases of:		Ichthyosis Hystrix .....	641
Heterochylia.		Diagnosis .....	642
Hyperemesis Gravidarum. See Preg-		Pathology .....	642
nancy, Disorders of.		Etiology .....	642
Hyperemia, Bier's Treatment by .....	580	Prognosis .....	642
Technique .....	581	Treatment .....	642
Causes of Failure .....	582	Icterus. See Liver, Diseases of.	
Advantages .....	582	Ileus. See Intestines, Diseases of: In-	
Indications for Use .....	582	testinal Obstruction.	
Surgical Principles Involved .....	582	Impetigo Contagiosa .....	644
General Precautions .....	583	Definition .....	644
Elastic Bandage .....	583	Symptoms .....	644
Tension of Bandage .....	584	Etiology .....	644
Precautions in the Use of the		Treatment .....	645
Bandage .....	584	Impetigo Herpetiformis .....	646
Retention of the Bandage .....	586	Definition .....	646
Suction Glasses .....	587	Symptoms .....	646
Size of Glass .....	588	Etiology .....	646
Degree of Suction .....	588	Treatment .....	647
Application .....	588	Impotence .....	647
Precautions .....	589	Definition .....	647
After-treatment .....	589	Varieties and Causes .....	647
Hot-air .....	589	Treatment .....	647
Hot-air Douche .....	589	Indicanuria .....	648
The Hot-air Chamber .....	590	Definition .....	648
Technique .....	590	Symptoms .....	648
Indications .....	590	Heller's Test .....	648
Special Therapeutics .....	591	Jaffé's Test .....	648
Surgery .....	591	Senator's Modified Jaffé's Test .....	648
Internal Disorders .....	592	Daland's Test .....	648
Ophthalmology, Otolaryngology, and Laryn-		Holland's Test .....	648
gology .....	593	Obermayer's Test .....	648
Gynecology, Obstetrics, Urology, and		Barberio's Test .....	649
Proctology .....	594	Etiology .....	649
Dermatology .....	595	Treatment .....	653
Concomitant Medical Treatment .....	595	Indicanemia .....	654
Hyperesthetic Rhinitis .....	595	Infant Feeding and Nursing. See Nurs-	
Synonyms .....	595	ing and Artificial Feeding.	
Definition .....	595	Infantile Paralysis. See Spinal Cord,	
Symptoms .....	595	Diseases of.	
Etiology and Pathogenesis .....	596	Infantile Scorbutus .....	654
Treatment .....	601	Definition .....	654
Climatic Treatment .....	609	Symptoms .....	655
Surgical Treatment .....	609	Complications .....	656
Intraneural Injections of Alcohol ..	609	Diagnosis .....	656
Hysteria .....	610	Etiology .....	657
Symptoms .....	613	Pathological Anatomy .....	658

	PAGE		PAGE
Infantile Scorbutus ( <i>continued</i> ).		Intestines, Diseases of the Intestinal	
Prognosis .....	659	Neuroses ( <i>continued</i> ).	
Treatment .....	659	C. Secretory Disorders .....	699
Influenza, or La Grippe .....	659	Mucous Colitis .....	699
Definition .....	659	Synonyms .....	699
Symptoms .....	659	Definition .....	699
Clinical Types .....	661	Symptoms .....	700
Complications and Sequelæ .....	662	Diagnosis .....	702
Respiratory Tract .....	662	Etiology .....	702
Nervous System .....	664	Pathology .....	703
Circulatory System .....	664	Prognosis .....	703
Special Sense Organs .....	665	Treatment .....	703
Hemorrhagic Complications .....	665	Intestinal Catarrh .....	706
Miscellaneous .....	666	Synonyms .....	706
Diagnosis .....	666	Definition .....	706
Etiology .....	667	Symptoms .....	706
Pathology .....	668	Acute Form .....	706
Prognosis .....	669	Duodenitis .....	707
Prophylaxis .....	669	Jejunitis and Ileitis .....	707
Treatment .....	671	Colitis .....	707
Infusions, Saline .....	678	Proctitis .....	707
Intravenous Infusion .....	678	Chronic Form .....	707
Solutions .....	678	War Enteritis or Trench Diar-	
Apparatus .....	679	rhea .....	708
Asepsis .....	679	Diagnosis .....	708
Details of the Solution .....	679	Etiology .....	709
Operative Site .....	680	Morbid Anatomy .....	710
Preparation of the Patient .....	680	Prognosis .....	710
Operative Technique .....	680	Treatment .....	711
Intra-arterial Infusion .....	682	Phlegmonous Enteritis .....	714
Intraperitoneal Infusion .....	682	Croupous or Diphtherial Enteritis .....	714
Hypodermoclysis .....	683	Definition .....	714
Apparatus .....	683	Symptoms .....	714
Asepsis .....	683	Etiology .....	714
Details of the Solution .....	683	Prognosis .....	715
Injection Sites .....	683	Treatment .....	715
Technique .....	683	Celiac Disease .....	715
Painless Hypodermoclysis .....	683	Definition .....	715
Internal Ear, Disorders of .....	684	Symptoms .....	715
Tuning-fork Tests .....	684	Treatment .....	715
Barany Tests .....	685	Sprue or Psilosis .....	715
Syphilis .....	688	Definition .....	715
Treatment .....	688	Symptoms .....	715
Labyrinthine Effusion (Ménière's Dis-		Diagnosis .....	716
ease) .....	688	Etiology .....	716
Labyrinthitis .....	689	Morbid Anatomy .....	716
Treatment .....	690	Prognosis .....	717
Occupation-deafness .....	690	Treatment .....	717
Tinnitus .....	691	Hill Diarrhea .....	718
Intertrigo, Erythema Intertrigo, or Chaf-		Definition .....	718
ing .....	691	Symptoms .....	718
Definition .....	691	Etiology .....	718
Symptoms .....	691	Pathology .....	718
Diagnosis .....	692	Treatment .....	718
Etiology .....	692	Cholera Morbus .....	718
Treatment .....	692	Synonyms .....	718
Intestinal Parasites. See Parasites, Dis-		Definition .....	718
eases Due to.		Symptoms .....	718
Intestines, Diseases of the .....	694	Diagnosis .....	719
Normal and Pathological Physiology .....	694	Etiology .....	719
Intestinal Neuroses .....	697	Pathology .....	719
A. Motor Disturbances .....	697	Prognosis .....	719
Nervous Diarrhea .....	697	Treatment .....	719
Intestinal Spasm .....	698	Cholera Asiatica .....	719
Intestinal Paralysis .....	698	Definition .....	719
Treatment .....	698	Historical Note .....	720
B. Sensory Disorders .....	698	Symptoms .....	720
Treatment .....	699	Complications and Sequelæ .....	723

	PAGE		PAGE
Intestines, Diseases of the, Cholera Asiatica ( <i>continued</i> ).		Intestines, Diseases of the, Intestinal Obstruction, Etiology ( <i>continued</i> ).	
Diagnosis .....	723	Coprostasis; Gall-stones; Enteroliths; Foreign Bodies .....	766
Etiology .....	724	Intestinal Paresis, Postoperative Obstruction, or Paralytic Ileus .....	766
Pathology .....	726	Pathology .....	767
Prognosis .....	727	Prognosis .....	768
Prophylaxis .....	727	Treatment .....	768
Treatment .....	729	Visceroptosis .....	770
Intestinal Infarction .....	734	Synonyms .....	770
Intestinal Ulcers .....	737	Definition .....	770
Duodenal Ulcer .....	737	Symptoms .....	771
Definition .....	737	Diagnosis .....	774
Symptoms .....	737	Etiology .....	775
Diagnosis .....	740	Mechanism .....	776
Etiology .....	745	Pathology .....	778
Pathology .....	746	Prognosis .....	778
Prognosis .....	747	Treatment .....	779
Treatment .....	747	Intestinal Stasis; Coprostasis .....	784
Simple Follicular Ulcers .....	749	Definition .....	784
Stercoral Ulcers .....	750	Symptoms .....	784
Treatment .....	750	Diagnosis .....	786
Ulcerative Colitis .....	750	Treatment .....	788
Symptoms .....	750	Hirschsprung's Disease or Congenital Megacolon .....	791
Diagnosis .....	750	Definition .....	791
Prognosis .....	751	Symptoms .....	791
Treatment .....	751	Diagnosis .....	792
Duodenal Diverticulum .....	752	Pathology .....	792
Intestinal Tuberculosis .....	753	Treatment .....	793
Etiology .....	753	Intravenous Therapy .....	794
Pathology .....	753	Risks of Intravenous Injection .....	794
Symptoms .....	754	Technique .....	795
Diagnosis .....	754	Preparation of Drugs and Indications .....	796
Treatment .....	755	Intubation of the Larynx .....	796
Intestinal Sand .....	756	Indications .....	797
Intestinal Calculi .....	757	Intubation in Diphtheria .....	798
Intestinal Obstruction .....	757	Technique .....	799
Definition .....	757	After-treatment of Intubated Cases .....	806
Symptoms .....	757	Obstruction of Tube .....	807
Acute Obstruction .....	757	Extraction of Tube .....	807
Chronic Obstruction .....	759	Prolonged Use of Tube .....	809
Diagnosis .....	759	Modifications of O'Dwyer's Instruments .....	812
Etiology .....	762	Comparative Value of Intubation .....	813
Strangulation .....	762		
Intussusception .....	763		
Volvulus .....	764		
Tumors .....	765		
Strictures .....	765		

# SAJOUS'S

## ANALYTIC CYCLOPEDIA

### of PRACTICAL MEDICINE

#### G

**GAS, POISONING BY (Coal or Illuminating Gas).**—Carbon gases are sufficiently toxic when inhaled to cause many deaths yearly. One of the illuminating gases, acetylene, a product of calcium carbide, was considered in Vol. I (see article ACETYLENE); those to be reviewed under the present head will be the ordinary "burning" or "illuminating" gases, and coal gas derived from partly consumed combustibles, coal, wood, charcoal, etc.—all of which owe their toxicity to carbon monoxide.

#### ILLUMINATING GAS.

The toxicity of ordinary illuminating gas depends mainly upon the proportion of carbon monoxide (CO) it contains. Thus, while gas obtained by the distillation of coal contains about 8 per cent. of carbon monoxide, water gas, generated through the action of steam on highly heated coke or coal, contains over 30 per cent. As a result, the introduction of the modern water gas has greatly increased the mortality ratio of illuminating gas, even taking into account the vast increase in the public use of this commodity, and including among deaths only those recorded as due to accidental or intentional (suicidal)

causes. How many deaths are indirectly traceable to gas which leaks into the inadequately aired dwellings is unknown; they are doubtless many.

The coma, tissue degenerations, and death after several days, from carbon monoxide poisoning, are not due to retention of the gas but to injury to the brain and other organs by insufficiency of oxygen while the patient was breathing the gas. Henderson (Jour. Amer. Med. Assoc., Aug. 19, 1916).

A case of massive intoxication by carbon monoxide, treated by **artificial respiration and inhalation of oxygen**, illustrated the instability of CO-hemoglobin in the presence of oxygen, and the possibility of survival after a concentration of CO-hemoglobin which in this case was certainly above 50 per cent. Panis and Salmon (Presse méd., Mar. 26, 1924).

Pure carbon monoxide is one of the most insidious poisons known. It is without odor, the penetrating odor of illuminating gas being due to other relatively harmless constituents. It may be inhaled, therefore, in considerable amount without being noticed.

Poisoning by odorless illuminating gas in 12 persons sleeping in the same house. They suffered from intractable vomiting, violent headache, and lassitude. As none of the guests who slept out of the house were

affected, and three persons who slept in the basement of the house and did not share in the festivities were included among the sufferers, the food and drink of the party were clearly not to blame. The patients recovered during the day, but on the second night their condition was similar to, but even worse than on the first night. They recovered as soon as they slept elsewhere, and three volunteers who slept in the house developed the same symptoms. The mystery was solved when, several yards from the house, a leak was detected in a gas pipe as it passed over a water pipe. The escaping gas was deodorized by the earth through which it filtered, and its course was through the old cesspool, and up a ventilation shaft which opened under the house, and thus enabled the gas to invade all the rooms. E. Thomsen (Clinical Jour., from Petersburger med. Zeit., p. 30, 1913).

Having an affinity for hemoglobin three hundred times as great as oxygen, carbon monoxide attaches itself firmly to this pigment and deprives the blood of its oxygenizing property.

**SYMPTOMS.**—The effects of illuminating gas may be of two kinds: *acute*, such as those due to the accidental or purposeful inhalation of large quantities of gas within a short time, and *chronic*, such as due to the slow but continuous inhalation of gas from leaky pipes, or the CO-laden air of gas or smelting works, coke or charcoal furnaces, etc.

**ACUTE POISONING.**—In the majority of instances acute intoxication is due to escaping gas owing to imperfect closure of a stopcock or to the inhalation of gas with suicidal intent. The patient is usually found unconscious with flaccid limbs, or in a condition of spastic stiffness or rigidity if the poisoning is very deep. The face is flushed or very red—the blood

itself becoming cherry red—and in severe poisoning cyanotic, though in some cases there is pallor.

In every case of poisoning by the oxide of carbon the blood suffers characteristic changes. The blood takes a special cherry-red color which cannot be confounded with any other, so that on the dissecting table the special poison is detected by means of spectroscopic examinations. The oxide of carbon, *in vivo* as *in vitro*, substitutes the oxygen of the oxy-hemoglobin, leading to a formation of carboxyhemoglobin of cherry-red color. This special color of the blood, which already appears extensively in all the visible mucous membranes, is more apparent in the serous membranes and especially in the brain. De Dominicis (Semaine méd., Feb. 20, 1913).

The respiration is shallow, though regular, slow, and often stertorous. The pulse is slow, becoming weaker as the toxemia increases. The pupils are small and react feebly to the light; there may be fibrillary muscular contractions or twitchings, tremor or spasm with muscular cramps and trismus. Occasionally tetanus or violent convulsions are witnessed, with paralysis of the sphincters. There is no suffering, however. In unfavorable cases the coma deepens and the patient passes away without marked preagonal phenomena, excepting in some instances a marked rise of temperature, which, on the whole, had previously shown but a small rise. The presence of coma does not, however, always mean a fatal ending. In favorable cases the morbid signs slowly disappear owing to the gradual elimination of carbon monoxide from the blood.

Carbon monoxide inhalation causes in animals and in man a rise in intracranial pressure, which shows two

distinct elevations: The first occurs during asphyxia and is caused by congestion due to a rise in arterial pressure; the second occurs after asphyxia and is caused probably by edema. The intracranial pressure is of sufficient height to produce transient eyeground changes observable by the ophthalmoscope. To offset this factor the authors tried **intravenous injection of hypertonic saline solution**, known to cause absorption of water by the blood from the tissues, obtaining reduction of the increased brain bulk and relief from compression. In a man it relieved a stuporous condition, accompanied by an abnormally high spinal fluid pressure and headache, of 24 hours' duration, due to asphyxia by illuminating gas. H. S. Forbes, S. Cobb and F. Fremont-Smith (Arch. of Neurol. and Psych., Mar., 1924).

The following *tannin test* for the detection of CO in the blood, taken from Hawk, is delicate and practical: Divide the blood to be tested into 2 portions, and dilute each with 4 volumes of distilled water. Place the diluted blood mixtures in 2 small flasks or large test-tubes and add 20 drops of 10 per cent. solution of potassium ferrieyanide. Allow both solutions to stand for a few minutes, then stopper the vessels and shake one vigorously for 10 to 15 minutes, occasionally removing the stopper to permit air to enter the vessel. Add 5 to 10 drops of yellow ammonium sulphide and 10 c.c. of 10 per cent. solution of tannin to each flask. The shaken flask will soon show a dirty olive green precipitate, whereas the flask which was not shaken and which, therefore, still contains CO-hemoglobin, will exhibit a bright red precipitate characteristic of CO-hemoglobin. This test is more delicate than the spectroscopic test, and serves to detect the presence of as low a content as 5 per cent. of CO-hemoglobin. E. M. Vaughan (Med. Jour. and Rec., Oct. 15, 1924).

#### **AUTOMOBILE GAS POISONING.**—The noxious fumes and gases

emitted by automobiles have become a source of danger mainly to the automobilist himself who uses small closed cars, and when in small garages, with doors and windows closed, the engines are allowed to run for testing and other purposes. Many deaths have occurred from this cause in this and other countries. An unusual amount of carbon monoxide may be set free from low grade gasoline when the air-supply is deficient. The exhaust gases may then contain as much as 20 per cent. of carbon monoxide.

Haldane has demonstrated that 0.05 per cent. of carbon monoxide in air may produce symptoms of poisoning; 0.1 per cent. will cause headache and palpitation, while 0.2 per cent. is absolutely dangerous. Carbon monoxide is invisible and merely detectable by the symptoms it produces if inhaled. It is lighter than air, and so when emitted from a moving car will ascend and quickly become diluted.

A small automobile, rated at 23 horse-power, was found to discharge about 25 cu. ft. of exhaust gas per minute, containing 5.5 to 6.8 per cent. of carbon monoxide. Thus, about 1.5 cu. ft. of the latter gas were produced per minute. In a closed space measuring 10 by 20 feet, discharge of 1 cu. ft. of this gas per minute would yield the dangerous concentration of 15 parts in 10,000 in 3 minutes. Henderson, Haggard, Teague, Prince and Wunderlich (Jour. of Ind. Hyg., July and Aug., 1921).

**AFTER-EFFECTS.**—Sometimes, where the carbon-monoxide intoxication has been profound, the recovery is only apparent. Soon, the patient begins to suffer from headache and weakness, amnesia, mental torpor, drowsiness, and shows contracted pupils, though they may react to light,



more or less marked fibrillary contraction, and finally death from asthenia without apparent suffering.

Case of a woman of 37, who was unconscious for 4 days. Areas of necrosis were found scattered over her body. Nine days after the poisoning she developed retention of urine and feces. The functions were regained four days later. The manifestations in this case are ascribed by the authors to hemorrhage into the *conus medullaris*. Girault and Richard (*Presse méd.*, July 1, 1922).

In other cases the after-effects, though not entailing death, may be very severe, especially in the direction of the cerebrospinal system and the mind. The various nervous sequelæ may include cerebral hemorrhage, hemiplegia, paraplegia, partial paralyzes, various paresthesias, hyperesthesia, anesthesia, multiple sclerosis, hysteria, chorea, tetany, and disorders of sight and hearing. The mental morbid phenomena witnessed include amnesia, melancholia, mental torpor, mental confusion, temporary mania, dementia, aphasia, and feeble-mindedness.

The nervous symptoms are both varied and inconstant. Convulsions occur in about 7 per cent. of all cases and muscular rigidity in a slightly larger proportion. The reflex and pupil symptoms show great variability. The coma bears no definite relation to the intensity or duration of the fever. Coma lasting four or five days is not invariably fatal. In the series of 90 comatose cases only 17 cases, or 18.8 per cent., were fatal. Pneumonia is an infrequent complication, and in a large percentage of fatal cases the cause of death may be referred to cerebral lesions, such as congestion of the meninges and brain substance, hemorrhage of the cerebral capillaries, or hemorrhage into and softening of the internal capsule,

lenticular nucleus, and adjacent structures. Thompson (*Med. Record*, July 9, 1904).

Report of a case of asphyxiation from coal gas. The patient after a prolonged convalescence left the hospital after a stay of fourteen weeks. He reported incidents of early life and childhood usually well, recognized his old acquaintances and repeated their names, but had no recollection of anything that transpired from thirty-six to forty-eight hours prior to the accident nor what happened afterward. He died suddenly three weeks after his discharge. Sanger Brown (*Jour. Amer. Med. Assoc.*, April 28, 1906).

Microscopically, very definite lesions of the brain can be demonstrated. The cortical vessels are dilated, but in the subcortical white matter the changes are more marked—viz., congestion, hemorrhage, and the rupture of small vessels. Sometimes this rupture is into the brain substance, sometimes into the perivascular sheath. The capillary endothelium appears swollen and shows fatty changes. The most marked changes are seen in the white matter of the *centrum ovale*, especially in the occipital lobe. F. W. Mott (*"Arch. of Neurol."*, Claybury Asylum, vol. iii, p. 246).

How does the CO act on the nervous system?

There are 2 principal hypotheses in this connection: (a) That all the symptoms are produced by the anoxemia due to the action of the CO on the oxyhemoglobin of the red cells, with resulting deprivation of oxygen to the nervous tissue and vascular changes—hemorrhages, thromboses, and degenerations; (b) Le Dosseur's theory that the CO, having once saturated the red cells, becomes dissolved in the serum and attaches itself to the nerve-cells and has a direct toxic effect on them.

Which, if either, of these two views is the correct one remains to be proved. A. J. Hall (*Lancet*, May 28, 1910).

Case of illuminating-gas poisoning followed some weeks after apparent recovery by an attack of confusional insanity, somewhat resembling the Korsakoff syndrome. The symptoms disappeared in about six weeks' time, and the patient was discharged as completely recovered four months after admission to the asylum. The frequency of gas poisoning has increased since the general use of "water gas" for illuminating purposes. Mary O'Malley (*Jour. Amer. Med. Assoc.*, Oct 26, 1912).

Thrombi capable of causing gangrene may also be formed under the influence of carbon monoxide. A striking peculiarity is a persistent and high leucocyte count, which rises, according to W. G. Thompson, in many cases above 18,000 and in fatal cases as high as 50,000. A high degree of leucocytosis is an unfavorable prognostic sign.

Case of poisoning by burning gas, resulting in gangrene of both legs. The illuminating gas which was the cause was found to contain 7 per cent. of carbon monoxide. The case, the writer thinks, demonstrates that the effects of carbon-monoxide poisoning are more far-reaching than has been generally supposed and that, though recovery may apparently be complete in a few days or even a few weeks, startling and irreparable damage may have been done to the tissues. In this case diabetic gangrene, chemical gangrene, senile gangrene, and gangrene from exposure to extremes of temperature can all be excluded. Thrombotic and embolic gangrene can also be excluded. McLean (*Jour. Amer. Med. Assoc.*, May 20, 1911).

The writers observed a patient, a man, in whom, about 3 weeks after poisoning with illuminating gas, there developed gangrene of the foot and phlegmasia alba dolens. The case ended in recovery. Laignel-Lavastine and Alajouanine (*Bull. de la Soc. Méd. des Hôp.*, Apr. 15, 1921).

**CHRONIC POISONING.**—In this form, due to the prolonged inhalation of small quantities of carbon monoxide from a leaky pipe, smelting works, etc., headache (apt to be worse in the morning and very severe if the proportion of gas in the air is anything but very small), vertigo, tinnitus aurium, nausea, ephemeral rises of temperature, especially during the afternoon, may suggest malaria and even typhoid fever. As a rule, however, the symptoms are vague and misleading, suggesting anemia. Mild frontal headache (worse in the morning), tinnitus, vertigo with anorexia and a bad taste in the mouth, frequent indigestion, colicky pains, constipation, and lassitude constitute the average syndromes observed.

Chronic carbon-monoxide poisoning occurs more frequently than is imagined, and is undoubtedly responsible for many obscure conditions which occur in the practice of every physician and often remain an unsolved puzzle. The large increase in the use of gas for cooking purposes will not lessen the evil, and we should be prepared to make a diagnosis of this toxic condition as readily as we do of the acute form. A more extensive use of the spectroscope in daily clinical work should be made, as skill with the instrument is easily acquired. That chronic poisoning by illuminating gas should occur seems inexcusable if proper precautions are taken to see that gas-fixtures are impermeable to gas. Servants should be apprised of the danger of not turning off the valves of gas-ranges completely. T. J. Yarrow (*Amer. Medicine*, Aug. 30, 1902).

The case histories of 35 persons who for years during their working hours had to breathe air containing from 1 per 10,000 to 1000 carbon monoxide. In the course of years they all developed nervous, digestive and general symptoms varying in

tensity, but most severe in the work-rooms with the highest proportion of the impurity in the air. The syndrome was alike in each case, commencing with headache and occasional dizziness, then lassitude, loss of appetite, insomnia varied with nightmares followed, and neuralgias, intense or slight, transient or fixed, unilateral or bilateral, intercostal, subcostal, abdominal, and especially in the lumbar and sacral region. The digestive disturbances were those characteristic of hyperchlorhydria; 12 of the patients had intermittent albuminuria, 3 transient glycosuria, and all grew thin and pale, some being so sallow as to suggest cancer. Epileptics were made much worse. All the symptoms reached their acme in winter, passing off during the summer vacation at first. In later years they became more continuous, with lesser remissions. In one case incipient tabes was diagnosed. A few others presented signs of congestion in the bladder and prostate. Courmont, Morel and Mouriquand (Bull. de l'Acad. de Méd., Dec. 20, 1910).

Stress laid on the dangers of repeated inhalation of minute amounts of carbon monoxide in dwellings. There may result, *c.g.*, headache, vertigo, tinnitus, flashes of light, weakness or absence of tendon and pupillary reflexes, nausea, epigastric pain, palpitation, languor, weakness and incoördination, convulsive movements, mental disturbances, and hallucinations of sight and hearing. An entire family, living in a house with a defective furnace, suffered from hallucinations. In addition, a boy of 13 had gastric disturbance, anemia, and difficulty in reading. An apparent interstitial optic neuritis, with marked contraction of the visual fields, was found, and some years later he still had enlarged blind spots and marked paracentral scotomas. Wilmer (Amer. Jour. of Ophth., Feb., 1920).

Vomiting in an infant a few weeks old was traced to carbon monoxide in the house. When the child was taken elsewhere the vomiting ceased

at once, returned promptly when it was brought back, and again ceased when it was permanently moved. Railliet (Nourrisson, May, 1922).

Danger of chronic carbon monoxide poisoning because of heavy automobile traffic emphasized. The practitioner should go into the living conditions of his patients and inquire into the possibility of such poisoning from automobile engines in those suffering from headache, gastro-intestinal disturbances, anemia, lowered nutrition and neurasthenia. E. A. Shumway (Med. Jour. and Rec., June 3, 1925).

**TREATMENT.**—In the *acute* form of illuminating-gas poisoning, as has been emphasized by McCombs, the essential treatment, in all stages, consists in the inhalation of **oxygen**, under pressure whenever possible, and in sufficient quantities to displace as much as possible the carbon monoxide combined with the hemoglobin.

In the *first stage*, *i.e.*, that preceding the loss of consciousness, **fresh air** combined with mild stimulation, such as **aromatic spirit of ammonia**, should be practised. In this stage the nausea, vomiting, and headache are the most troublesome symptoms. The greater part of the gastric symptoms will be relieved by some effervescing salt, the patients feeling much better after cructating or vomiting. **Effervescing phosphate of sodium** may be used. The headache usually persists for twenty-four or forty-eight hours and may be relieved by any of the drugs used for this condition. Violent exertion is to be avoided, as collapse is a danger; men who have become aggressively delirious have collapsed.

In the *second stage*, in which the patient is unconscious but breathing, it may be necessary, if the respirations are not stertorous, to assist the

respiratory action. The Howard **artificial respiration** method (compression of the lower part of the chest in rhythm with expiration, explained in the article on DROWNING) has been found efficient. **Oxygen** must be administered, preferably under pressure.

**Oxygen** will drive off CO from hemoglobin if supplied in sufficient amount. For full efficiency it should be breathed through a mask that will separate the inspired from the expired gas. It should be given continuously for 45 to 60 minutes and later for 30 minutes in every hour for 4 or 5 hours. M. Nicloux (*Presse méd.*, Sept. 3, 1921).

A closed anesthesia mask or an emergency pasteboard mask, made to fit as tightly as possible, should be used in administering **oxygen**. Binet (*Presse méd.*, May 15, 1920).

Various mechanical devices for administering artificial respiration and supplying oxygen have been tried, the most successful being those of the type of the "**pulmotor**," described in the article on OXYGEN.

Stimulants, such as **camphor**, **caffeine**, **digitalis**, and **strychnine**, should be freely administered hypodermically. As there are several instances in which the persons have collapsed when taken out into cold air, it is at times best to start treatment in a warm room. An important adjunct is **massaging of the muscles** after aerating the lungs, the resulting increase in the general circulation often promptly restoring oxygen balance.

In experiments on **lobeline** in CO poisoning, the writers used cats, poisoned until the respiratory center was paralyzed. Upon injection of the drug, the breathing returned. Behrens and Pulewka (*Klin. Woch.*, Sept. 9, 1924).

The above methods are usually followed by prompt recovery. If they

are not successful, **venesection**, with the introduction of normal **salt solution**, may be employed, and has been followed by rapid recovery. A method more particularly favored, however, when it is feasible is the inhalation of a mixture of **carbon dioxide**, 5 per cent., with **oxygen**, 95 per cent., as advised by Haggard and Henderson.

Oxygen treatment is often too long delayed to be effective, a condition of post-asphyxial coma, due to edema and degenerative processes of the brain, occurring even after most of the CO has been eliminated. The writers recommend immediate **manual artificial respiration** by the **prone pressure** (Schafer) method in patients whose breathing has stopped or become very weak, with or followed by inhalation of a **mixture of oxygen and 5 per cent. carbon dioxide**. They deem **venesection** probably injurious on account of further depletion of the oxygen-transporting power of the blood, and consider **blood transfusion** would be effective only if performed within 1 or at most 2 hours after termination of the toxic inhalation. Henderson, Haggard and Scott (*Jour. Amer. Med. Assoc.*, Sept. 30, 1922).

Out of 300 organizations possessing approved apparatus for **carbon dioxide-oxygen inhalation**, 110 replied in detail to a letter of inquiry. The treatment is exceedingly valuable in mild gassing, relieving or preventing headache, nausea, etc. Patients seriously gassed but still breathing revive rapidly and thoroughly. It is practicable to use the treatment with prone pressure artificial respiration when breathing has ceased. C. K. Drinker (*Jour. of Industr. Hyg.*, Dec., 1925).

The patient should be taken from the room, into **fresh air**, and the tongue held out. If necessary, **artificial respiration** should be begun at once. A pint to a pint and a half of **blood** should be **removed**, and simultaneously a quart of normal **saline solution** transfused into the

opposite forearm. **Venesection** can be repeated two hours after the first bloodletting, if the patient be not doing well. Saline solution should be given subcutaneously every two hours in quantities of one pint, or by the rectum continuously. Saline solution diminishes toxemia, lessens the tendency to edema of the lungs, increases the affinity of red cells for oxygen, and stimulates the circulatory system. At the outset the patient should be given by hypodermic injection **ether** 30 minims (2 c.c.), **atropine**  $\frac{1}{100}$  grain (0.00065 Gm.), and **adrenalin** 30 minims (2 c.c.). Nitroglycerin and vasodilators in general should be avoided. Jones (Amer. Jour. Med. Sci., Jan., 1909).

In carbon monoxide poisoning the **prolonged inhalation of pure oxygen** as soon as possible will insure resurrection. In animals deeply intoxicated practically all the carbon monoxide had disappeared from the blood by the end of an hour of continuous oxygen inhalation. M. Nicloux (Presse méd., Mar. 15, 1917).

The "pulmotor" has increased the chances of recovery, but, should it fail, the best method is the direct **transfusion of blood** as practised by Crile. (See under **INFUSION**, this volume.)

Experiments made by the writers upon 15 dogs showed the following results: Of cases in which the heart had stopped: (1) Blood transfusion saved 3 out of 6; (2) intravenous saline injection, none saved; (3) simple manipulation saved none. Of cases in which the heart had almost stopped: (1) Blood transfusion saved 4, 1 died; (2) intravenous saline injection saved none. The authors' conclusions are: (1) **Blood transfusion** seems to be of greater therapeutic value than other measures. (2) Transfusion should be commenced as soon as the heart stops beating to insure the best results. It will not be efficacious after the heart stops finally. Crile and Lenhart (Amer. Jour. Med. Sci., Oct., 1907).

In the *third stage*, with the patient not breathing and unconscious, **artificial respiration, oxygen, stimulation, and heat** are imperative. **Transfusion** is indicated. The Schäfer, or "prone-pressure," method of artificial respiration is the best to use. (The various methods of artificial respiration are described under **DROWNING**, Vol. IV.)

Artificial respiration has been maintained for six hours, with subsequent recovery of the patient.

If the above methods of treatment are carried out and the patient is not dead when discovered, practically all cases should recover in forty-eight to seventy-two hours from the immediate effects of the gas. The great difficulty in treatment has been the failure of both laymen and physicians to realize that inhalation of **oxygen** under pressure, combined with **venesection** or **blood transfusion** in severe poisoning, will save practically all cases.

Personal case. The patient was well covered with blankets and surrounded by **hot-water bottles**, and was given  $\frac{1}{30}$  grain (0.0022 Gm.) of **strychnine** hypodermically. The median basilic vein of the right arm was **opened** and 300 c.c. ( $\frac{3}{8}$  pint) of **blood** allowed to flow, after which an **intravenous transfusion** of 1200 c.c. (2 $\frac{1}{2}$  pints) of a 0.7 normal **saline solution** was given. Inhalations of **oxygen** were also given. Three hours later the face was somewhat reddened and the patient was perspiring, but was still comatose. Temperature was 100° F. (37.8° C.), pulse 136, respiration 32; 2 grains (0.13 Gm.) of **caffeine sodium benzoate** were given hypodermically every four hours. After another three hours the patient responded somewhat to **external stimulation**, but was still comatose. Temperature was 101° F. (38.3° C.), pulse 120, respiration 36. At the end of an

other three hours the condition was about the same. On the second day the face and hands of the patient had assumed a distinct cherry hue. The man was drowsy, responded very slowly to questions, after answering which he immediately sank into sleep. The treatment consisted of the administration of **strychnine**,  $\frac{1}{30}$  grain (0.0022 Gm.), and **caffeine sodium benzoate**, 2 grains, given hypodermically every 4 hours. Nourishment consisted of 6 ounces of milk and 12 ounces of water. On the third day consciousness returned. Ravine (Jour. Amer. Med. Assoc., June 3, 1911).

### COAL GAS FROM STOVES, FURNACES, ETC., POISONING BY.

Although the odor of this gas differs totally from that of illuminating gas, the pathogenic cause is the same: carbon monoxide. Illuminating gas, as previously stated, owes its odor to its other constituents, which include benzine. The proportion of CO being greater, however, in stove or heater coal gas, its toxicity is correspondingly greater.

Case of a man and 2 horses, all killed by carbon-monoxide poisoning. They had slept in a stable which was in the basement of a house and the symptoms of the poisoning were very distinct. It appeared that the gas had been generated in a stove in a small room which communicated with a passage leading to the stable, had passed along this passage and killed the man and the 2 horses in the lowest part. The generation of the gas was favored in that the fire in the stove was kept low. K. Wolf (Münch. med. Woch., Feb. 10, 1903).

The symptoms and treatment of coal-gas poisoning do not differ from those of intoxication by illuminating gas described in the foregoing pages.

During carbon monoxide asphyxia there is vigorous hyperpnea, followed by a diminished production of CO<sub>2</sub>.

Due to deficiency of CO<sub>2</sub> in the blood, asphyxiated animals, when restored to pure air, exhibit for one-half hour or more great depression of breathing. Tissue asphyxia thus continues, although the body is surrounded by fresh air. This post-gassing period is of critical importance. While oxygen inhalation during this period had only a slight effect, not being adequately inspired, that of CO<sub>2</sub> diluted with air immediately increased breathing and thus hastened the elimination of carbon monoxide. But the inhalation of oxygen plus CO<sub>2</sub> proved far more effective than either gas alone, the augmented breathing allowing the oxygen to effect a rapid displacement of carbon monoxide from the blood. Henderson and Haggard (Jour. Pharm. and Exper. Therap., Aug., 1920).

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**GAS OF WARFARE.—SYMPTOMS.**—Pneumotoxic warfare or "gassing," consists in the use of vapor derived from some toxic or irritating substance, chlorine, prussic acid, etc., to kill or disable the enemy, first used by the Germans in the recent war. There are said to be, according to J. C. McWalter (Clin. Jour., May 10, 1916), 43 different gases capable of being used. They may be discharged from reservoirs, as drift gas, or in an explosive or asphyxiating shell, as shell gas. The drift gas is mostly chlorine, forming a heavy greenish-yellow cloud, and often causing sudden death from edema of the glottis. Bromine is said also to be present, causing the stupor which often follows, and extreme lacrymation. Sulphurous acid and the hydrogen compounds of arsenic and phosphorus are also used.

When a man is "gassed" 3 stages are observed: (1) That in which he dies within the first couple of hours. His face is greenish-yellow, due to shock, edema of the glottis, and poisoning by the gases. (2) The second stage is described by the soldier as "dryland drowning." There is edema of the lungs, a yellow, albuminous, chlorinous fluid fills the air passages, clogs the alveoli, and suddenly oozes into the

trachea with such copiousness that fluid may drop from the nose and throat. There is a violent shedding of epithelial cells, followed by acute emphysema, air escaping into the interstitial tissues, even in the neck and upper part of the chest. The patient suffers the torments of asphyxiation and toxemia alike in every anguished breath. Respirations may be 60 to 80 a minute and very shallow. Vomiting is frequent and copious, with intolerable pain in the epigastrium. The fluid is often thin and yellow, sometimes streaked with blood. In the earlier stage headache is almost constant. Of those arriving at the clearing stations, the mortality was probably about 7 per cent. Probably not more than 2 per cent. of those reaching the base hospitals succumbed, but a considerable percentage of asthmatic lung trouble, etc., persisted for months. (3) These are the cases seen in the home hospitals. There may be headache, bronchitis, gastric catarrh, pleuritis, and rapid respiration. Some show stupor and weakness of the legs. Exertion may bring on an asthmatoïd seizure, the roof of the mouth may be dry and glazed, and the tongue coated with a dry fur. There are also suggestions of collapse of the cerebrospinal system.

Another type of gas used during the war was a vesicating irritant to the skin and mucous membrane, the so-called "mustard gas," while the others produced death from inhalation. The vesicating gas as described by R. G. LeConte (U. S. Naval and Med. Bull., July, 1918) is most commonly dichlorethyl sulphide (does not contain mustard), and its irritating effect is not immediately noticeable. It pervades and penetrates the clothing, and the longer this is worn the more intense will be the burning. The handling of shell fragments, of the clothes, and any other article that has come in contact with this gas will burn the hands unless they are protected by leather or rubber gloves. When treatment is started early its effects are evanescent even on the conjunctivæ, and the patient will return to duty in a few days. Where treatment is delayed, the resultant burns may incapacitate for some weeks. The scrotum, inner surface of the thigh, and armpits are the portions of the body most severely burned.

**PATHOLOGY.**—Mott (Brit. Med. Jour., May 19, 1917) examined the brains of 2 cases of gas poisoning. The whole of the white matter was studded with small dark spots. These were due to hemorrhages, but microscopic examination showed conditions not found in carbon monoxide or other forms of gas poisoning. The red blood-corpuscles were largely broken up, and the hemoglobin converted into dark chocolate colored pigment granules, which filled the capillaries, arterioles and venules of the white matter. This was possibly methemoglobin.

Examination of the blood in 44 cases by Miller and Rainy (Lancet, May 26, 1917) showed that when symptoms persist, there is an increase in the number of lymphocytes, relative and absolute. In slight cases this may not be beyond the normal limits. If the percentage of lymphocytes approaches that of the polymorphonuclears, the case is still suffering from the effects of the gassing, provided there is no other complicating disease.

**PROPHYLAXIS.**—A mask or respirator saturated with a solution capable of absorbing the gas is generally employed. McWalter (*ibid.*) suggests that the following might, on emergency, be effective. A couple of folds of lint, saturated with a solution containing 10 per cent. of sodium bicarbonate, and 20 per cent. of sodium hyposulphite in water, and placed over the mouth and nose, seem to absorb chlorine, arseniuretted hydrogen, or other poisonous gas thoroughly.

In the Italian army, according to P. Sisto (Riforma medica, Nov. 20, 1916), the masks have layers of gauze impregnated with aqueous or glycerinated solution of potassium carbonate, sodium carbonate, or sodium hyposulphite which fix chlorine, bromine, and acid gases in general.

**TREATMENT.**—There is an overwhelming sensation of fatigue, which induces the man to lie down. He must, according to McWalter (*ibid.*), be kept moving. The best treatment is strychnine and atropine hypodermically, together with alcohol hypodermically or per rectum, if it cannot be taken orally.

Sisto (Riforma medica, Nov. 20, 1916) states that in the Italian army the treatment consists of inhalations of oxygen and

subcutaneous injections of **camphorated oil** and **ether**, **hypodermoclysis**, and **venesection**. **Blood-letting** is best done with the lancet, on account of the ready coagulability of the blood. **Digitalis** was of great service in the graver cases.

Hebbethwaite (Brit. Med. Jour., July 22, 1916) treated 30 cases of chlorine gas poisoning by **venesection**. It is indicated in all except the cyanotic cases, or where cardiac failure is paramount. The amount withdrawn ranges from 15 to 25 ounces, according to the patient. The results are relief of cyanosis, pulmonary congestion, and acute headache, while promoting sleep.

Boudreau (Jour. de méd. de Bordeaux, Sept., 1916) recommends **tincture of iodine** internally as a potent means to hasten restoration of living tissues. A drop or 2 of the French tincture is added to each glass of water, milk, tea or other beverage taken during the day, 5 to 7 doses being thus taken. The dose is increased by 1 drop each day until some of his patients reached hundreds of drops a day and kept this up a long time.

Sajous has recommended that **adrenalin** be used in these cases, inasmuch as it supplies the blood with the substance which takes up the oxygen of the air and becomes the active respiratory agent of the hemoglobin molecule. **Hypodermoclysis** in small quantities with adrenalin injected slowly into the rubber pipe carrying the saline commends itself as a useful procedure, and is advised for both acute and chronic cases.

For "mustard gas" poisoning treatment is started by making a change of clothing. At the advanced hospital patients are at once stripped and washed with **lime water**, the eyes bathed with it, and the mouth, nose, and pharynx treated with the same solution.

Lime water is specific and neutralizes the gas immediately.

Poisoning with chlorine or mustard gas causes chronic digestive disturbances oftener than poisoning by pallete or benzyl bromide. Such disturbances are met with in about 6 per cent. of the chlorine and mustard gas cases. M. Loeper (Bull. de l'Acad. de méd., Mar. 2, 1920).

Investigations made to determine the minimum concentration of mustard gas that will produce effects on the unprotected eye of man showed that the eyes are the structures of the body most sensitive to mustard gas. Concentrations of 0.0005 milligram of mustard gas to the litre of air—1 part in 10 millions—will produce visible eye reactions from less than 1 hour of exposure in individuals whose skin resistance is relatively high. C. I. Reed (Jour. Pharm. and Exper. Therap., Mar., 1920). S.

**GAULTHERIA.**—The *Gaultheria procumbens*, or wintergreen, is a small, shrub-like evergreen plant, bearing a small, red berry (called teaberry, checkerberry, partridge-berry, boxberry, or deerberry), which is edible. It is indigenous to the woods of the United States, from the extreme north down to the Carolinas. The leaves alone were used for the two preparations formerly in the U. S. P. By distillation of the leaves a volatile oil (*oleum gaultheriæ*, U. S. P. VIII) results. This oil is of a light-straw color, which becomes darker on exposure to the air. It possesses a peculiar penetrating odor, a sweetish, pungent, aromatic taste, and a slight acid reaction. It contains a hydrocarbon (*gaultherin*) and an acid (*methsalicylic acid*); consists almost entirely of pure methyl salicylate (96 per cent.). It is soluble in alcohol, ether, chloroform, and carbon disulphide. Besides having medicinal virtues, it may be used as a flavor. Methyl salicylate has been officially recognized as a complete substitute for oil of gaultheria.

**PREPARATIONS AND DOSE.**—*Oleum gaultheriæ*, U. S. P. VIII (oil of gaultheria), the dose of which is from 5 to 30 minims (0.3 to 2 c.c.), best given in emulsion or dropped on a lump of sugar, or in capsules. The latter, however, are apt to cause gastric disturbance by bringing the oil in contact with the gastric mucosa.

*Spiritus gaultheriæ* U. S. P. VIII (spirit of gaultheria), may be given in doses of from 10 to 20 minims (0.65 to 1.3 c.c.).

**PHYSIOLOGICAL ACTION.**—The physiological action of gaultheria is almost identical with that of salicylic acid



(*q.v.*); in small doses it is a stimulant and carminative. In larger doses it is an antiseptic, antipyretic, antirheumatic, and analgesic. In therapeutic doses the oil is entirely decomposed in the system, although in tonic doses it may escape in part unchanged by the urine.

#### POISONING BY GAULTHERIA.—

In slightly toxic doses there is produced a marked tinnitus aurium, nausea, vomiting, and rapid pulse. One ounce of the oil has proved fatal. In this case the principal symptoms were profound diaphoresis, pain in the head and abdomen, purging; frequent, painful, and at last involuntary micturition; with convulsions, tonic spasms, dilated pupils, lessening arterial pressure, abolition of sight and hearing, rapid respiration, depression of the heart's action, and finally death by respiratory failure in fifteen hours. In children 1 dram (4 c.c.) has sufficed to produce death. In a case reported by H. C. Dodge, the stomach was evacuated within fifteen minutes, and the child seemed relieved and slept for some hours. He then showed dyspnea, corroded tongue and lips, and diuresis. Convulsions, collapse, and death followed.

#### Treatment of Poisoning by Gaultheria.—

The stomach should be evacuated by means of an hypodermic injection of **apomorphine** ( $\frac{1}{10}$  to  $\frac{1}{4}$  grain—0.006 to 0.01 c.c.), or if conscious by any available **emetic**. Cardiac and respiratory stimulants (**ether**, **caffeine**, **strychnine**) are then indicated, using **artificial respiration**. Relieve convulsions or spasms by the hypodermic administration of **morphine**.

**THERAPEUTICS.**—The therapeutic uses of gaultheria are similar to those of salicylic acid. The oil is employed principally in the treatment of **acute articular rheumatism** in doses of 5 to 30 minims (0.3 to 2 c.c.), in capsules, in emulsion, or dropped on sugar, three or more times daily, as the case may require. Lint saturated with the oil, wrapped around the part affected, and covered with a piece of thin rubber cloth or rubber tissue to prevent evaporation, may be used, as suggested by Lannois and Limousin, in cases of **acute and chronic rheumatic joints**. The salicylates are more efficient in the various forms of rheumatism, and should be given preference.

Oil of gaultheria tried in 122 cases of **arthritis** of various kinds, with uniformly encouraging results. When combined with suitable balneotherapy, the patients were cured more rapidly than when treated with baths alone. It is administered in capsules, each capsule containing 18 drops of the oil. Two capsules are given at a time, beginning when retiring, two one hour later, and two more during the night. E. von Rottenbiller (Klinisch-therap. Woch., May 20, 1900). M.

**GAVAGE.**—This procedure, which at one time received much notoriety in the political campaign of the so-called "militant suffragists" in England, under the title of "forced feeding," consists in supplying food to the stomach through the intermediary of a stomach-tube. It is usually carried out through the mouth, but if the patient struggles or opposes the measures, as is usually the case with infants, the tube is introduced through the nose.

Gavage is resorted to in many conditions—after operations about the mouth or throat, **intubation**, **tracheotomy**, **laryngotomy**, etc.—which would be compromised by the process of deglutition of foodstuffs; and also when, as in the course of various acute diseases, **typhoid fever**, **scarlet fever**, **diphtheria**, etc., the patient will refuse nourishment, or, again, when the patient is unconscious, as after an attack of **apoplexy**. It is also useful in conditions such as **laryngeal tuberculosis**, **cancer of the esophagus**, **esophageal paralysis**, etc., when either through the excessive pain caused or mechanical impossibility the patient cannot swallow even soft foods or liquids. It is of considerable use in immature infants, or the normal processes of nursing or feeding, as in cleft palate, cannot be carried out.

**TECHNIQUE.**—The ordinary stomach-tube, provided with a soft catheter (No. 10 American for children) and a glass funnel of the capacity of about 1 pint, will serve for all purposes. But strict asepsis is necessary, particularly when the tube is used in infectious cases such as diphtheria, scarlet fever, and the like. It should be

carefully washed out and then immersed in an antiseptic solution, or, preferably, boiled.

Prior to insertion the tube or catheter should be immersed in warm water and lubricated with glycerin. In willing adults it is readily passed down the esophagus, on either side of the epiglottis, down the pyriform sinus. When opposition is encountered, as in the insane, children, etc., the patient should previously be wrapped, including arms and legs, in a strong sheet or blanket and the tube introduced gently through either nostril. It will glide down the esophagus if well lubricated with glycerin. There may be temporary resistance at first, on reaching the isthmus, but by waiting an instant the causative spasm of the isthmian muscles will cease and the tube will slip downward. The tube should not be forced down or introduced below the cardiac end of the esophagus to any extent; in infants the length of the latter canal is about seven inches from the gums; in a child 2 years old, nine inches; in one of 10 years, eleven inches; in an adult, about sixteen inches. The appropriate length of tube to be used should be marked on the tube and the mark taken as the limit when the tube is introduced.

Where the required amount of food has been administered by pouring it, in small quantities at a time, into the funnel, the tube is withdrawn, pinching it as this is being done, to avoid the spilling of food into the pharynx or larynx. The patient should remain quiet in the semirecumbent position for some time after the procedure. When gastric catarrh is present it is very advantageous to wash out the stomach with warm water fifteen to twenty minutes before resorting to gavage. S.

**GELATIN** is obtained from tendons, bones, hides, etc., of cattle and other animals. The crushed bone, hide shreds, etc., used for the purpose are first macerated and subjected to the action of lime or caustic soda in pits for two or three weeks. This dissolves the blood and saponifies the fats. The excess of lime or soda is then removed by washing, and the balance steamed to remove the gelatin, but an excess of heat is avoided. Sulphurous acid

is used to bleach the gelatin. When of sufficient strength, the gelatin is allowed to harden in molds or on slabs, and is ultimately dried in sheets on wire netting (Anderson).

**PREPARATIONS AND DOSE.**—The above mode of preparation, which is that of the commercial gelatin, obviously suggests the danger of contamination when used in injection. There were observed numerous cases of fatal tetanus when the use of gelatin was first introduced for the treatment of hemorrhage, hemophilia, aneurism, etc. The gelatin was found to contain bacilli or spores. This persisted until perfect sterilization of the gelatin had been obtained, and we now have such preparations at our disposal. Whenever it is used, therefore, for subcutaneous or intravenous injection, *gelatina sterilisata* should alone be employed.

In regard to the strength of the solution, there seems to be considerable divergence of opinion. Not infrequently a 10 per cent. solution of *gelatina sterilisata* has been employed for subcutaneous injection, preferably in saline solution at the body temperature.

The preferred situations for injections of gelatin are between the shoulder-blades, under the breast, and on the outer side of the thigh.

Originally, in cases of aneurism, a 1 to 5 per cent. solution of gelatin to the amount of 100 to 200 c.c. (3¼ to 6½ fluidounces) was injected slowly into the thigh, and repeated every 10 or 15 days until 10 to 20 injections had been administered. The procedure is not free from pain, and may induce a febrile movement.

The drug is official as *Gelatinum*, U. S. P. It is insoluble in cold water, but swells and softens in it, gradually absorbing 5 to 10 times its own weight of water. It is soluble in hot water, acetic acid, and in a hot mixture of glycerin and water, but is insoluble in alcohol, chloroform or ether.

It is also official in *Gelatinum glycerinatum*, U. S. P., made from gelatin and glycerin in equal parts, and used for making bougies, suppositories, etc.

The gelatin solution is warmed to the body temperature, and 10 c.c. (2½ drams) are injected by means of a

syringe that has previously been well warmed. The injection is made into the subcutaneous tissues of the thigh, the skin being raised for the purpose. The same quantity is injected into the corresponding part of the opposite thigh. The punctures are covered with iodoform gauze and adhesive plaster. The tumor-like swellings of the subcutaneous connective tissue are treated with warm, moist compresses to aid absorption. This part of the body appears more suitable for the injection than the intraclavicular region, recommended by others, or both sides of the back, for the patient usually lies on his back, and the injections are least inconvenient in the thighs. W. Engelmann (Deut. med. Woch., Nu. 24, 1910).

The styptic action of sterilized gelatin is equally marked when it is administered by the mouth. It becomes converted in the stomach into a substance known as *gelatose*, which is transmissible through the gastrointestinal mucous membranes.

The increase of coagulability of the blood is also produced when gelatin is given by the mouth. Dogs were experimented upon, and in 1 case the femoral artery was cut across after the animal had been fed upon gelatin digested by artificial gastric juice. Bleeding ceased entirely in one minute fifty seconds. As the author remarks, it must not be forgotten that dogs never bleed so freely as does man. In every case there was a distinct shortening of the time required for complete coagulation of the blood. In eight observations the average time for clotting before the administration of gelatose was three minutes forty-one seconds; after the gelatin had been taken, this time was reduced to one minute thirty-two seconds. Hence it follows that stomach digestion of gelatin does not destroy its coagulative properties, that gelatin is capable of absorption, and that, therefore, the administration of gelatin by the mouth in the treatment of hemorrhages is not

an entirely futile proceeding. H. C. Wood (Amer. Medicine, May 3, 1902).

**PHYSIOLOGICAL ACTION.**—In 1896 Dastre and Floresco found that the intravenous injection of a gelatin solution in animals caused the blood to coagulate more rapidly when withdrawn from the vessels, and that it antagonized the power of peptone in hindering coagulation of the blood. Camus and Gley explained the result by attributing it to the acidity of the gelatin solution; but Floresco, while admitting that the acid reaction has a certain influence, showed that neutralized gelatin is also active. Bauermeister explained it by an action in the leucocytes which are killed by the gelatin, and in dying produce the ferment which brings about blood coagulation. When injected subcutaneously the same effect is observed, but there is still much uncertainty regarding the rate and method of its absorption.

A 2 per cent. solution of gelatin in physiological saline solution, when injected hypodermically, is absorbed in proportion to the amount injected. Whether such injections hasten the coagulation of the blood seems a little doubtful, for in the animals experimented upon purely physiological variations in the time of coagulation (as estimated by comparison of the time of formation of the first layer of coagulum) were observed equal to those which seem to follow the gelatin injections. Endovenous injections undoubtedly hasten coagulation. The density of the blood is also modified by the injections. In 3 cases of **aneurism**, in which hypodermic injections were given, decided improvement occurred, although no definite cure. For example, in the first case (one of thoracic aneurism) 1250 c.c. (2½ pints) of a 2 per cent. gelatin solution were injected in seven doses in the course of two months, with the result that the area of dullness was diminished, the tumor reduced (as tested by radioscopy), the epigastric pulsation disappeared, and the fremitus and double murmur to the right of the

sternum disappeared. Mariani (Il Policlinico, Jan., 1901).

The explanations put forward regarding the coagulating action of gelatin are unsatisfactory. The action may be due to the presence of inorganic constituents, such as calcium. With this object in view the writer analyzed several specimens of gelatin, and proved calcium constantly present in the proportion of about 0.6 per cent. Consequently a patient in an injection of 100 c.c. (3½ ounces) of a 5 per cent. gelatin solution receives ½ grain (0.03 Gm.) of calcium, probably in an easily absorbable form. Zibell (Münch. med. Woch., Nu. 43, 1901).

While the manner in which gelatin may increase the coagulability of the blood has remained obscure, this may be due, according to Renard, to an increase of the fibrin ferment in the blood. Burton-Opitz noted increase of the blood viscosity upon intravenous injection of gelatin.

By injecting 25 to 40 c.c. (6 to 10 drams) of 10 per cent. Merck's sterilized gelatin, the author obtained an increase in the coagulability of the blood that appeared on an average two to four hours after the application. At first it lasted only a quarter to half a minute, though from hour to hour it increased until ten to twelve hours after the injection it had reached its maximum. The degree of increased coagulability varied in different experiments. The time of clotting usually declined by fully 66 per cent., and in isolated cases it declined as much as 85 per cent. This effect continued unabated for several hours. An explanation of the action of gelatin is still difficult to give. Grau (Deut. med. Woch., Nu. 27, 1910).

**THERAPEUTICS.**—Gelatin as previously stated is mainly used in all hemorrhagic conditions. Paul Carnot in 1898 treated a severe case of **epistaxis** in a hemophilic by the injection of a 5 per cent. gelatin solution into the nostril, and the bleeding stopped almost at once. A second similar case was successfully

treated by means of a 10 per cent. solution. Many other forms of **external hemorrhages** were controlled in the same way or by means of tampons soaked in the solution. Siredey used it locally in **metrorrhagia**, bleeding from **hemorrhoids**, **epistaxis**; and successful cases have been reported by others. Its action is rapid and lasting, and without danger. Poliakov reports a case of **hemorrhage from gastric ulcer** in which 6 ounces (180 c.c.) of a 10 per cent. solution given thrice in twenty-four hours stopped the bleeding. **Bleeding from the lower bowel** was also controlled by injections. Hemoptysis did not seem to be much benefited by its internal administration. Nogues treated cases of **hemorrhage from the bladder** by injections of gelatin solution into the organ. The viscus was first thoroughly washed out with boric lotion, and then several small injections of a 5 per cent. gelatin solution were given, and again washed out, the bladder ultimately being left partially filled with it.

The *subcutaneous* injection of gelatin to stop hemorrhage was first used by Lancereaux and Paulesco. Cases of **hemoptysis**, hemophilic bleedings, and **bleeding from toxemia** can all be treated in this way. Several physicians have used with success a 2 per cent. solution in hemoptysis, in **bleeding from the bowel in typhoid**, and in **hemophilia**. As a rule, about 6 ounces (180 c.c.) are injected daily for several days in succession. In obstinate hemorrhage after various operations it also proved effective, and likewise controlled several cases of bleeding of **purpura hemorrhagica**. The subcutaneous use of gelatin is indicated in all hemorrhages, such as **hematemesis**, **metrorrhagia**, **melaena neonatorum**, the **purpuric forms of the infectious diseases**, and is contraindicated only in acute nephritis and parenchymatous renal hemorrhage.

The writer used hypodermic injections of gelatin in 3 desperate cases of bleeding. In the first case the patient was a bleeder who had **uncontrollable hemorrhage** after extraction of a tooth. It recurred on the third day, and was treated by local application of a 10 per cent. gelatin solution and injection of 100 Gm. (3½ ounces) of a 2 per cent. gelatin saline solu-

tion into the upper part of the thigh. This caused the bleeding to cease in a few hours. The injection was repeated next day. There was no recurrence of hemorrhage. Injection area became painful, and after ten days an abscess was opened and found to contain sterile pus. In the second case a bleeder had epistaxis lasting for seven days. All ordinary treatment was useless, so 10 per cent. gelatin was used locally, and subcutaneously into each thigh, 100 gr. ( $7\frac{1}{2}$  Gm.) of 2 per cent. gelatin in saline solution were injected. There was albuminuria. The bleeding ceased. Next day patient developed pneumonia, and later he died. Gebele (Munch. med. Woch., Nu. 24, 1901).

In secondary **postoperative hemorrhage** the writer has obtained very good results with injections of gelatin solution. In such cases the bleeding wound should not be reopened immediately, but a gelatin injection given. Chaput (Munch. med. Woch., S. 317, 1909).

Good results from the use of gelatin in a case of **purpura hemorrhagica** with epistaxis, hemorrhage from the mouth, and melena were observed by the writer. Marfan (Munch. med. Woch., S. 317, 1909).

In **melena neonatorum** Vassmer has put on record a mortality of but 8.8 per cent. in 34 cases as compared to a previous mortality of 61.3 per cent. in 31 cases treated without gelatin.

As an easily digested food, capable of being substituted for  $\frac{1}{4}$  to  $\frac{3}{8}$  of the protein of an average diet (especially where an ample amount of carbohydrates is allowed), gelatin is given in soups and jellies.

Carnot has also advocated the use of gelatin by the mouth in lieu of agar-agar for the treatment of **constipation**. It takes up water readily and renders the feces more bulky and softer. Powdered or cut-up gelatin is given in doses of 2 to 5 Gm. (30 to 75 grains) during meals.

A new method of treating **catarrh of the large intestine** was tried by the writer in a number of cases. It consists in pouring hot gelatin solution

into the bowel. His reports deal almost exclusively with severe forms of chronic catarrh of the large intestine. The regular daily introduction of 40 to 80 Gm. ( $1\frac{1}{3}$  to  $2\frac{2}{3}$  ounces) of sterile gelatin in 400 to 500 c.c. ( $\frac{1}{4}$  to 1 pint) of Carlsbad water at  $45^{\circ}$  C. led in almost every case to a striking improvement. L. v. Aldor (Therap. Monatshefte, Nu. 4, S. 171, 1910).

Gelatin has other uses than for increasing coagulability. In any kind of case with a sluggish or stationary visceral lesion attended with **pain**, relief of the latter and acceleration of the process of repair may be obtained by giving daily subcutaneous injections of 5 or 10 c.c. (80 or 160 minims) of 5 per cent. gelatin solution. Ten cases are cited illustrating the utility of this measure, with or without a little phenol, in **angina pectoris**, **aortitis**, **hemoptysis** and **incipient tuberculosis**. In 60 cases of aneurism P. Mayer has had very good results from injections of 100 c.c. ( $3\frac{1}{3}$  fluid-ounces) of 2 per cent. gelatin solution at weekly intervals. Margulis (Prensa méd. Argent., Nov. 20, 1925). S.

**GELSEMIUM.**—This drug, also termed yellow jasmine, is the dried rhizome and rootlets of the *Gelsemium sempervirens*, a climbing plant indigenous to the southern United States. The odor is aromatic and oppressive and the taste bitter. Gelsemium contains a resinoid, gelsemin; an acid, gelsenic or gelseminic acid, and an alkaloid, gelseminine, which occurs in small, white, microscopic crystals, which have no odor, but an intensely persistent, bitter taste. The alkaloid forms salts which are freely soluble in water. The alkaloid itself is soluble in alcohol, ether, and chloroform.

**PREPARATIONS AND DOSE.**—The preparations of gelsemium were deleted from the U. S. P. X (1926). The following preparations (aside from the alkaloid) were recognized in U. S. P. IX:

*Extractum gelsemii* (extract of gelsemium), the dose of which is  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.01 to 0.03 Gm.).

*Fluidextractum gelsemii* (fluidextract of

gelsemium), the dose of which is 2 to 5 minims (0.12 to 0.3 c.c.).

The *tinctura gelsemii* (tincture of gelsemium), the dose of which is 4 to 12 minims (0.24 to 0.75 c.c.).

*Gelseminina* (gelseminine),  $\frac{1}{20}$  to  $\frac{1}{30}$  grain (0.0005 to 0.002 Gm.), should only be used with the greatest care.

Remedial properties of gelsemium depend upon two alkaloids which have been found in the rhizome and roots, namely, gelsemine and gelseminine. The former, gelsemine, resembles strychnine in its action, but beyond this very little is known about it.

Gelsemium usually depends upon gelseminine for its effect, this being present in quantities that overbalance the gelsemine. Gelseminine does not increase arterial tension, but rather lessens it. It is one of the most certain and powerful depressors of the motor nerves. It is indicated in all cases where there is hyperemia of the brain or the cord; in fact, in all cerebrospinal inflammations and hyperemias, but not in passive congestions. Reading the surface indications, the eclectics recommended gelsemium when the face is flushed, the eye bright, the pupil contracted, the head hot, and the patient presents restlessness and excitability. It is most effective in the earlier stages of fever with sthenic manifestations. In small doses it is likewise of value in many forms of nervous irritability. The dose of gelseminine ordinarily employed for an adult is  $\frac{1}{250}$  grain (0.00025 Gm.), and this may be repeated every ten, fifteen, or thirty minutes as the occasion requires, until drooping of the eyelids and weakness of the lower jaw indicate a full and beginning toxic action of the drug. W. F. Waugh (Amer. Jour. Clin. Med., Dec., 1907).

**PHYSIOLOGICAL ACTION.**—Gelsemium depresses the cardiac action and the general circulation. It depresses the vagal, respiratory, and heat centers. These phenomena are produced in some even by small (10 drop) doses of the tincture, for

example, as observed by Muenich. In therapeutic doses gelsemium does not produce gastric irritation. The active principle diffuses into the blood with great facility. In moderate doses gelsemium causes a feeling of languor and calm, slowing of the heart-action, drooping of the eyelids, dilatation of the pupils, and some feebleness of muscular movement. In larger doses gelsemium causes vertigo, amblyopia, diplopia, paralysis of the muscles of the upper eyelid so that it cannot be raised, dilated pupil, labored respiration, slow and feeble action of the heart, great muscular weakness, and diminished sensibility to pain and touch. These effects follow in a half-hour after stomach ingestion and last two or three hours, when they subside.

Gelsemium is a powerful though ephemeral mydriatic when a solution is applied. It produces this effect by paralyzing the peripheral oculomotor nerves.

#### POISONING BY GELSEMIUM.

—When lethal doses are taken the physiological effects are intensified. A staggering gait is followed by a loss of muscular power and a sense of general numbness over the whole body. The eyelids close; the muscles become paralyzed, those of the jaw first; the pupils become widely dilated and fail to respond to the stimulus of light; vision is lost. The lower jaw drops, the tongue becomes paralyzed, and speech is lost. The respirations are irregular, shallow, and labored. The heart action and pulse become feeble and weak and then intermittent. The skin is generally covered with a profuse perspiration. The body heat is markedly lowered. Internal strabismus is apt to occur (paralysis of sixth pair); the face becomes pinched and anxious. Death occurs from centric respiratory failure.

Case of poisoning observed from the tincture of gelsemium administered to a woman aged 40 suffering from severe neuralgia; 10-minim (0.6 c.c.) doses every two or three hours were given the first day, and, no relief being obtained, 20-minim (1.25 c.c.) doses were administered for another twenty-four hours. Symptoms of poisoning then came on, consisting in a total loss of power in the

tongue, alteration in vision, with widely dilated pupils, and uncertain power of the muscles of the hand and arm. The patient was perfectly conscious. Then  $\frac{1}{20}$  grain (0.0005 Gm.) of strychnine was injected, and in ten minutes a change for the better was noted. The vision was not perfectly restored for some hours. Edward Jepson (Brit. Med. Jour., Sept. 19, 1891).

Though consciousness is present for a long time, drowsiness or stupor finally appears.

**Treatment of Gelsemium Poisoning.**—The evacuation of the stomach by means of emetics or the stomach-pump should be followed by the use of cardiac stimulants (ammonia and digitalis), the application of artificial respiration, external heat, and the hypodermic administration of atropine and strychnine to stimulate the respiratory center. The maintenance of the horizontal posture is desirable. Faradization and the hot and cold douche are to be borne in mind.

**THERAPEUTICS.**—Exaltation of sensory or motor function is an indication for the use of gelsemium. Small doses should be used at first, until the susceptibility of the patient is ascertained. Ptosis, or drooping of the upper eyelid, gives warning that the physiological action of the drug is present.

**Cerebral Disorders.**—In mania with great motor excitement and wakefulness, Bartholow considered gelsemium superior to conium.

To produce the best results, sufficiently large doses should be given to produce definite physiological effects: Dilated pupil, drooping of the eyelids, and a feeling of languor. The excitement incident to acute alcoholism, simple wakefulness, and the insomnia following too great mental or physical activity are often benefited by gelsemium. In meningitis and cerebrospinal meningitis, Bartholow recommended the fluidextract in 5-minim (0.6 c.c.) doses every two hours to maintain the physiological effect. According to Garland, there is no drug equal to gelsemium in those crises of cerebral excitement which were formerly combated by asafetida and valerian.

**Spasmodic Disorders.**—In spasmodic cough, with little or no secretion from the bronchial tubes, gelsemium generally gives prompt relief.

The drug has been recommended as a useful remedy in the spasmodic stage of pertussis, the nervous cough of hysteria, the nagging cough of phthisis with scanty secretion, and in reflex cough from irritation of the laryngeal nerves. Hysterical spasms are controlled by gelsemium, the patient becoming calm and tractable.

Chorea, laryngismus stridulus, and spasmodic dysuria have yielded to gelsemium in many cases. Torticollis and localized facial spasm may be relieved by the drug.

**Neuralgias.**—Facial, intercostal, ovarian, and other neuralgias have proved amenable to gelsemium. Large doses are sometimes necessary, relief not appearing until the characteristic drooping of the eye, dilated pupil, and muscular languor appear. From 5 to 20 minims (0.3 to 1.25 c.c.) of the fluidextract every three hours may be required. Gelsemium is considered by Jackson the remedy *par excellence* for neuralgias of the lower jaw and the acute congestive stage of cold in the head.

**Fevers.**—Excellent results have been claimed from the use of gelsemium in pneumonia and pleurisy. In the former it diminished respiratory activity, affording rest to the inflamed organ; it allays cough, lessens stasis of the pulmonary capillaries, and lowers the temperature. Bartholow used to give 5 to 10 minims (0.3 to 0.6 c.c.) of the fluidextract every two hours to sustain the effect. The same method is employed in pleurisy. It is also regarded as a valuable agent to abort acute coryza.

**Bilious and malarial fevers** have been treated by the administration of gelsemium, especially in the Southern States, where it has enjoyed the reputation of a specific. Its utility is probably due to its antipyretic action.

**Skin Disorders.**—Bulkley has recommended gelsemium for the relief of itching in eczema: 3 to 10 drops of the tincture are given and increased every half-hour until the physiological effects are observed or the patient relieved. Not more than 1 dram (4 Gm.) should be given in all within two hours.

**Mydriasis.**—Gelseminine in watery solution (1 to 64) has been recommended by Tweedy for use as a mydriatic. He believes it equal to atropine. The effects disappear more rapidly. Its use is not without danger; it has not come into general favor. W.

**GENERAL PARALYSIS, OR PARESIS.** See MENTAL DISEASES.

**GENTIAN.**—Gentian (*Gentiana*, U. S. P.) is the root of the *Gentiana lutea*, or yellow gentian, indigenous to Europe. The root contains a bitter principle, *gentianin*, and an acid, *gentianic* or *gentisic acid*.

**PREPARATIONS AND DOSES.**—The *tinctura gentianæ composita*, U. S. P. (compound tincture); dose, 1 to 2 drams (4 to 8 c.c.); composed of gentian, bitter orange peel, and cardamom.

The *fluidextractum gentianæ*, U. S. P. IX (fluidextract of gentian); dose, 15 minims to 1 dram (1 to 4 c.c.).

The *extractum gentianæ*, U. S. P. IX (solid extract of gentian); dose, 2 to 8 grains (0.13 to 0.5 Gm.).

**PHYSIOLOGICAL ACTION.**—Owing mainly to its extreme bitterness and to the reflex stimulation through the sensory end-organs it produces, gentian increases the flow of saliva and the secretion of the gastric juice. Increased appetite follows its use. Most authors ascribe this favorable influence on the appetite to two factors: The marked bitterness, which increases the desire for food, and the improved digestive power, which, enabling more food to be disposed of, postpones the sense of satiety.

It favors assimilation by stimulating also the intestinal mucous membrane. This ceases after long use, and the effects of overstimulation are observed.

**THERAPEUTICS.**—Gentian is a valuable bitter tonic. It is indicated in **convalescence** from acute maladies, in **atonic dyspepsia**, in **chronic gastric catarrh**, in **malarial fevers**, and in **chronic malarial poisoning**. The compound tincture of gentian (gentian, orange peel, and cardamom seeds) is a very useful stomachic.

Gentiana quinqueflora is regarded by J. R. Cross as a reliable prophylactic against abortion and all uterine disorders. He

found it especially valuable in **menorrhagia** or **metrorrhagia** depending wholly upon systemic causes, using a tincture prepared as follows: *Gentiana quinqueflora*, bruised fine, 4 ounces (120 Gm.); alcohol, 24 ounces (720 c.c.); pure distilled water, 8 ounces (240 c.c.). The mixture is allowed to stand for fourteen days; it is filtered and is then ready for use. The tincture is given in doses of a tablespoonful every four hours. H.

**GENU VALGUM AND VARUM.** See ORTHOPEDIC SURGERY.

**GERMAN MEASLES.** See RUBELLA.

**GESTATION, ECTOPIC.** See PREGNANCY.

**GINGER INEBRIETY.** See ZINGIBERIS.

**GLANDERS, OR FARCY.**—**DEFINITION.**—This disease develops primarily in the nasal passages and bronchial tubes of horses and cattle, producing a mucous flow. It has been found to be due to the *Bacillus mallei*. Large nodules form in the respiratory passages, and metastatic nodules in the liver, spleen, etc.

**SYMPTOMS.**—In man the disease does not often present itself. However, veterinary surgeons, butchers, and those surrounded with horses are likely to contract the disease. This was well shown by an unusual accident which occurred recently in the public institute for the examination of food at Czernowitz. Dr. Luksch, the chief bacteriologist, while making some investigations on the *Bacillus mallei* put a large quantity of the bacilli, obtained from an animal from the slaughter house, into a centrifuge. The tube containing the glanders bacilli burst and the contents were scattered over the laboratory. The



fragments of glass were picked up by some of the persons working in the room, and, as it was believed that the bacilli were dead or inert, no great precautions were taken to prevent infection. In the course of a few days all those who were in the room at the time of the accident developed symptoms of glanders especially of the tracheal and pulmonary type, and two of the victims died within forty-eight hours after the onset of the disease. Dr. Luksch also fell ill.

Glanders occurs in the conjunctiva and on the skin after some insignificant injury. Nodules result and the disease sometimes takes an acute form, beginning generally with malaise, pain in the limbs and back, and terminates in the breaking out of several abscesses over the body.

The term *farcy* designates more particularly those cases in which nodules arise beneath the skin; abscesses form, and the pus discharged is often gelatinous and occasionally red in color.

Case of glanders in a physician, who had operated on another case without gloves. The incubation period was only a few hours. The symptoms during the first week in both cases were merely those common to any grave general infection. The significant phlegmons in the neck and the abscess in the popliteal region did not develop until the 8th and 9th days. Couréménos and Kéchissoglou (Bull. Soc. méd. des hôp. de Paris, June 9, 1922).

Glanders can also, as shown below, assume chronicity. As has well been emphasized by Cramp, cases of chronic glanders can easily be overlooked unless one is constantly on the lookout for the disease.

Case in a man aged 35, with chills and high fever for 2 weeks, followed

by depression, emaciation, anorexia, and constipation. Later there was fever every second or third day, and subsequently every fourth or sixth day. Six months after the onset there was nocturnal pain in the left shoulder, and 2 months later a nodule appeared on the leg, from which *B. mallei* was obtained. There followed a large suppurating lesion on the lower half of the leg. Before the discovery of the organism tentative diagnoses of malaria, rheumatism and tuberculous, syphilitic or mycotic gumma had been made. Delamare and Noury (Bull. de l'Acad. de méd., Apr. 4, 1922).

In 2 cases of chronic glanders appearing in the feet of 2 brothers, aged 23 and 25, the writers isolated from the lesions and pus a bacillus not strictly aerobic, negative to the Gram stain, and staining with fuchsin and methylene blue. Inoculation tests were made on cats, rabbits and other animals. The bacillus tended to produce necrosis rather than granuloma. It seems to have been an attenuated form of the *Bacillus mallei*, for which the authors suggest the name *B. paramallei*. A. Reverdin and A. Grumbach (Ann. de méd., Jan., 1924).

Multiple abscess on the extremities, without definite cause, should excite suspicion, as Robin has shown that in 80 per cent. of cases multiple abscesses occur. In his case there was no direct association with horses. There was never any nasal discharge. The patient remained apparently cured for six weeks and then showed a return of symptoms.

Extreme exposure to bad weather seems to predispose to recurrence of glanders lesions.

The incubation period appears to vary from a few hours to a year, the most usual period being four to seven days. Long periods of freedom from any manifestation are a striking feature of chronic glanders. The variety is marked in the initial stages, and continues throughout the

course of the disease. Typhoid fever, septicemia, pneumonia, and rheumatism are only a few of the diagnoses which have been made at the onset; the initial rash when present has most often been mistaken for that of small-pox. The later manifestations simulate nearly all those of syphilis and tubercle, from gummata to osteomyelitis and meningitis. It is difficult to give the average duration, but a considerable proportion of patients die within four months. There are, however, numerous instances where the patient has lived for two or three years, while there are two recorded cases of six and one of fifteen years' duration. It has been estimated that about 60 per cent. of the chronic patients recover. This figure is certainly in excess of the true one, in view of the fact that many patients are considered cured and lost sight of immediately afterward. Seeing, however, the long periods of latency recorded, it is most likely that a certain percentage relapses. Addison and Hett (*Lancet*, Oct. 23, 1909).

**DIAGNOSIS.**—When the disease occurs in the mouth or nose, bacilli can be found in the mucous flow. When the disease starts internally the bacillus may be found in the sputum, or when the secondary abscesses form. It is of the greatest importance that these should be early recognized.

Another very satisfactory method, especially in cases of nasal and pulmonary glanders, is to inoculate some of the morbid products, or mallein, into animals.

Six cases of human glanders, 3 of which proved fatal. All of the patients gave histories of occupations bringing them into more or less close connection with horses. In 3 cases diagnostic injections of mallein were given, and in all a typical reaction followed. The dose used was 10 to 15 minims. For practical purposes animal inoculation was found to be the most reliable diagnostic pro-

cedure. It was tried in 4 cases with positive results, and in 1 afforded the only means of arriving at a positive diagnosis. An emulsion of the suspected tissue should be inoculated subcutaneously into the abdomen of an adult guinea-pig. If inoculated intraperitoneally the contaminating germs may cause death from peritonitis before the characteristic enlargement of the testes with acute inflammation and engorgement of the tunicae vaginales is produced. The reaction is noticeable in seven to ten days as a rule, but may be delayed for several weeks. Bacterioscopic diagnosis from smears of pus is often most unsatisfactory, the bacilli being generally very scanty. But the cultural characteristics are so definite and so constant as to render the diagnosis simple. Smears of pus on glycerin-agar produce in twenty-four hours a gelatinous, confluent growth, and on potato a brownish growth in forty-eight hours. Histologically there is only one feature characteristic of glandrous lesions—the peculiar nuclear degeneration known as chromatotaxis. The bacilli are rarely to be found in the blood, and leucocytosis is not a marked feature. Bernstein and Carling (*Brit. Med. Jour.*, Feb. 6, 1909).

It is comparatively easy to distinguish the disease from symptomatically similar conditions. The small number of cases reported has given rise to the opinion that the disease is rare in the human subject and that human susceptibility to the infection is slight; but it is probable that fatal cases occur and are reported under other diagnosis, notably small-pox. The case reported was suspected to be small-pox (see the annexed illustrations), but bacteriological examination gave a positive diagnosis of glanders. Hence possible error unless one is careful in the examination of the stained smears or cultures. The deeper staining globules of the glanders bacilli may appear like groups of staphylococci, especially when the bacilli are in dense clumps,

as is often the case in the thick smears from cultures. In gross appearance fresh agar cultures of the pus may also resemble those of *Staphylococcus aureus*, which may explain the frequency of such contamination reported in the literature of bacteriological examinations of glanders. In very thin smears from glanders cultures the apparent cocci are seen to be deeply staining portions of chromatic globules within the faintly staining ground substance of

a microscopic examination as a guide to dosage. A culture from the swab often aids in the early diagnosis. Both guinea-pigs should be kept under observation for a month, and if a lesion of any kind is present autopsy should be performed and cultures made. Arms (Jour. Amer. Med. Assoc., Aug. 13, 1910).

Other methods, especially the complement fixation test and Pirquet's method, are also available.



Fig. 1.—Pustular eruption of acute glanders as exhibited on the day of patient's death, twenty-eight days after initial chill. (Zeit.)  
(Journal of the American Medical Association.)

the bacilli. F. R. Zeit (Jour. Amer. Med. Assoc., Jan. 16, 1909).

Strauss discovered in 1886 that material containing virulent *Bacilli mallei*, when inoculated into the peritoneal cavity of male guinea-pigs, developed lesions about the scrotum. This is regarded as the most satisfactory test at present available.

In the diagnosis of glanders the Strauss method is the best; more than one guinea-pig should be used. Before inoculating it is well to make

The Pirquet method for diagnosis of glanders was applied by the writer on himself, infected with glanders in 1894, reaction being obtained from mallein applied to cutaneous ulcers. No reaction was obtained in 10 control persons, however, the skin of whom was scarified and mallein applied. In several other cases seen during the past year mallein obtained a distinct reaction in case of glanders, though not in controls. In 1 case a positive reaction was obtained with mallein through the conjunctiva. Martel (Berl. klin. Woch., March 2, 1908).

Positive agglutination of the *Bacillus mallei* by horse serum in dilution of 1:1000 indicates latent or active infection of the horse furnishing the serum, while in human cases agglutination with dilutions above 1:100 would indicate glanders. Collins (Jour. of Infect. Dis., Oct., 1908).

The complement-fixation test supplemented by the agglutination test on all negative serums recommended. Glanders antigen, prepared without shaking, but filtered through a Berkefeld candle, gives reliable results. Antigens and agglutination fluid should be prepared from several strains of *B. mallei*. In guinea-pig inoculation, failure to develop lesions is not proof of the absence of glanders. Wade (Jour. of Infect. Dis., Jan., 1913).

**TREATMENT.**—When the cause is local, energetic measures should be pursued. The erosion or seat of infection should be completely removed by means of the knife, and cauterizing by means of the thermocautery. Some advocate merely incision and cauterization. Constitutionally, the administration of mercury has been recommended. Gralevsky obtained two recoveries by incising and disinfecting the abscesses and ordering daily inunctions of 1 dram (4 Gm.) of gray ointment. Claudius has used creosote with apparent benefit.

Vaccine therapy seems to have given better results than any other measure. An autogenous vaccine, injected at short intervals in doses gradually increasing from 5 to 200 millions, is preferred.

Tincture of iodine, followed by ichthyol, may be applied over swollen lymphatic glands and vessels. Abscesses should be incised and treated with pure phenol followed by alcohol. Sinuses may be irrigated with hydrogen peroxide solution or a much diluted tincture of iodine.

Ulcerations in the nasal cavities are treated with phenol or zinc chloride. For nasal douching, boric acid or potassium permanganate solutions are availed of.

In chronic glanders treatment has seemed of little value. Injections of mallein have been recommended by Bonomé, while mercurial inunctions, according to Gold, have cured some cases. Potassium iodide and sodium benzoate have also been used.



Fig. 2.—Cover glass smear from opened pustule, showing glanders bacilli. (Zeit.)  
(Journal of the American Medical Association.)

Case of glanders which for 3 years had been diagnosed in turn as tertiary syphilis, carcinoma, and lupus. When autogenous vaccine was used, it looked at first as if necrosis would destroy the patient's nose, but after 5 injections this organ began to heal and the healing process progressed with the further injections. Fischer (Deut. med. Woch., Jan. 15, 1920).

Chronic glanders of the mucosa in man is usually fatal. A case is cited which was apparently cured by autogenous vaccine, no relapse having occurred up to 3 months when the patient was last seen. Zieler (Deut. med. Woch., Feb. 19, 1920).

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**GLAUCOMA.**—To preserve the shape and proper relations of the refracting surfaces of the eyeball, the sclerocorneal coat is kept distended by its contents, which normally press outward with a force equal to the weight of a column of mercury 25 or 30 millimeters in height. To nourish the tissues contained within the outer coat of the eyeball there is a continuous secretion of nutritive fluid; and this fluid, just as constantly, must escape from the eyeball to avoid overdistending it. In pathological conditions the tension of the eyeball may be increased or diminished. Increased tension is indicated by + T 1, + T 2, or + T 3, which indicate different degrees of hardness; and diminished tension is indicated by — T 1, — T 2, or — T 3, the higher number indicating the greater departure from the normal; or it may be indicated by the corresponding number of millimeters of mercury as shown by the tonometer.

*Increased tension* is generally called *glaucoma*, from the Greek, *γλαυχός*, sea-green. The term was applied on account of the greenish hue of the pupil in elderly people, when dilated, as it commonly is, in glaucoma. But the increased intraocular tension is now recognized as the essential characteristic of the disease.

**SYMPTOMS.**—The eyeball is found more resistant to pressure than normal. This is tested by pressing on it above or below the cornea through the partly closed lids. The tips of the two forefingers are commonly used. In the early stages the increased resistance may not be noticeable or it may only be present a part of the time. More accurate information is obtained by the use of

the tonometer, which is pressed upon the center of the cornea, while the eye is directed upward. For this test the eye is anesthetized by instilling a 2 per cent. solution of holocaine, as cocaine is liable to alter the intraocular pressure.

A very early symptom is the appearance of colored rings around distant lights at night. The colors are arranged as in the solar spectrum, with the violet toward the light. These halos may be absent in glaucoma, or present when the tension is not increased. Proximity of the iris to the cornea, shallowness of the anterior chamber, frequently precedes any outbreak of other symptoms; and in the later stages the anterior chamber may be obliterated, the iris coming into contact with the cornea. Dilatation of the pupil usually attends glaucoma. In the early stages the pupil still responds to light and convergence, and varies in size from time to time with the variations of tension. Later it becomes widely dilated and fixed. When the tension of the eyeball is much increased, or has increased rapidly, the cornea is found comparatively insensitive to touch.

Pain occurs, and is severe in most cases. It may be limited to paroxysms, or may be constantly present. It is often referred chiefly to the brow or cheek, or the temple or side of the nose. It may be mistaken for neuralgia or the pain of inflammation. In glaucoma that has lasted some time, the large tortuous veins that emerge from the sclera some distance back from the corneal margin are dilated and prominent. During the paroxysms there is generally a marked pericorneal redness. When the tension is very high, or has risen

rapidly, the cornea will be found hazy,—“steamy,”—and may hide the deeper parts of the eye.

When the media are clear the ophthalmoscopic appearances are characteristic. In cases not too recent the optic disc is cupped or excavated deeply, the excavation extending to the extreme margin of the disc, and having abrupt or overhanging sides over which the retinal vessels appear sharply bent. The retinal veins are often dilated and the arteries rather small. The arteries may be seen to pulsate, especially where they pass over the margins of the cup; and the normal pulsation of the veins may be increased. The optic disc is often surrounded by a ring of choroidal atrophy having an edge that shades rather gradually into the normal choroid, called a haloatrophy.

**DIAGNOSIS.**—Glaucoma may be distinguished from *cataract* by pain, dilatation of the pupil, narrowing of the field of vision, cupping of the optic disc, and absence of opacity of the media except during inflammatory exacerbations. From *neuralgia* it must be distinguished by the fundus changes, and the impairment of visual acuteness or the field of vision, that are present in simple glaucoma, which is most liable to be confounded with that disease. From *iritis* glaucoma is distinguished by the shallow anterior chamber, the dilated pupil, the impairment of the field of vision, the absence of so-called punctate keratitis, and the marked exacerbations and remissions. From *keratitis* glaucoma may be known by the symptoms just enumerated, and the smoothness of the corneal surface. In doubtful cases repeated measurements of the intraocular pressure

with the tonometer must be relied on to determine the presence of glaucoma. The discrimination between different varieties has been indicated in describing them.

**ETIOLOGY.**—Glaucoma may possibly be caused by excessive secretion of fluid within the eyeball; or by alterations in such fluid which hinder its escape. But the causes that most commonly produce it, and are best understood, act by causing obstruction of the channels of outflow.

The chief channels for the escape of fluid from the eye pass from the periphery or “angle” of the anterior chamber through “Fontana’s space” to a circle of lymphatic and venous channels in the adjoining sclera, called the canal of Schlemm. Adhesion of the periphery of the iris to the cornea or pressure of the iris against the cornea closes these channels.

The liability to glaucoma increases with age; and Priestley Smith has pointed out that the crystalline lens, like other epithelial structures, continues to grow until old age, diminishing the space between it and the ciliary processes, and increasing the liability of these processes to be pressed against the iris and close the outflow channels.

The use of a mydriatic is liable to cause glaucoma through thickening of the iris at its periphery during dilatation of the pupil. Exclusion of the pupil by iritic adhesions is likely to lead to pushing forward of the iris by fluid from the deeper parts of the eye, and blocking of the outflow channels. Dislocation or swelling of the crystalline lens is likely to do the same thing. Causes of swelling of the ciliary processes and iris, as over-

weariness and physical or mental shock, may cause outbreaks of glaucoma; and constitutional conditions, particularly gout, have been accused of causing it. Pain, insensitiveness of the cornea, and cupping of the optic disc are due to the excessive intraocular pressure.

**VARIETIES.**—Glaucoma in its typical form is marked with exacerbations, during which the tension of the eyeball is increased, with pericorneal redness, increased pain, diminished acuteness of vision, and generally increased severity of all the symptoms. This has been called *inflammatory glaucoma*. It is either *acute* or *chronic*. Sometimes the exacerbation is so severe as to destroy light perception in a few days, or even a few hours—*glaucoma fulminans*. When the increase of tension is preceded or accompanied by retinal hemorrhages it is called *hemorrhagic glaucoma*. Glaucoma quickly returning after iridectomy and compelling the removal of the eye is *malignant*.

When no noticeable exacerbations occur, but the increase of tension and impairment of vision are gradually progressive, the condition is called one of *simple glaucoma*. In simple glaucoma the increase of tension may, for a long time, be scarcely perceptible; or much of the time the tension of the eyeball may be quite within the normal limits. When glaucoma arises in an eye not previously diseased it is called *primary*. When it follows other ocular disease or injury, as wounds causing swelling of the crystalline lens, inflammation of the iris, or intraocular tumor, it is called *secondary glaucoma*.

When the vision has been entirely lost, and the tension is con-

tinuously elevated, the case is said to be one of *absolute glaucoma*.

**PROGNOSIS.**—Glaucoma not efficiently treated ultimately causes complete and hopeless blindness, usually with a period of great pain. This end may be reached in a few days or only after many years. Treatment may save what sight remains, or some that has been very recently lost may be restored. But vision that has been lost more than a few days or weeks cannot be regained. The prognosis for hemorrhagic glaucoma is extremely bad. Simple glaucoma often pursues its course unchecked by any treatment. Inflammatory glaucoma is quite amenable to the usual remedial measures if applied early. Secondary glaucoma can be cured by removal of its cause, as by the extraction of a swelled or dislocated crystalline lens. The prognosis must always be guarded, for cases mild in the beginning may become fulminating or malignant.

**TREATMENT.**—**Iridectomy** is the chief remedy for inflammatory glaucoma. It is best done by making with a narrow knife an incision a little back from the corneal margin close to the periphery of the iris. One-fifth of the iris should be removed, quite up to its ciliary attachment. For chronic inflammatory or simple glaucoma **sclerectomy** may be substituted or combined with iridectomy. The scleral incision is made quite obliquely, so that the anterior lip of the wound forms a long flap. The free end of this flap is then cut off with scissors, leaving a triangular, subconjunctival opening in the sclera. A piece of iris may then be excised, constituting the operation of *Lamprogrange*. An opening may be made

in the sclera by *trepthing*. A conjunctival flap is formed, large enough to cover the whole region of the opening. This is laid back and separated from the deeper tissue well into the margin of the cornea. A trephine 2 mm. or less in diameter is then applied and rotated until it cuts through into the periphery of the anterior chamber. The button thus formed is removed, and if the iris tends to prolapse a small portion is excised. The conjunctiva is then replaced and the scleral opening drains the interior of the eyeball into the subconjunctival space. This operation is chiefly used for simple glaucoma. In *cyclo-dialysis* an incision is made through the sclera run back from the corneal margin, and a spatula thrust between the sclera and ciliary body into the anterior chamber.

**Sclerotomy** may be anterior or posterior. The former consists in making a scleral incision parallel to the corneal margin much as for iridectomy, but longer and not completed, a bridge of sclera being left standing at the middle of it. Posterior sclerotomy consists in making an incision in the direction of an anteroposterior meridian of the eyeball, usually below the tendon of the external rectus, allowing a little of the vitreous to escape.

The common causes of glaucoma must be avoided, particularly the use of a mydriatic, unless iritic adhesions (posterior synechiae) are present. If operation is not permitted, myotics—as **physostigmine (eserine)** and **pilocarpine**—may be instilled, combined with **cocaine**. Taking blood from the temple and local application of **hot water** to the eye tend to diminish pain.

Operations to establish a filtering scar by incarceration or prolapse of the iris in scleral wound have been devised by Holth and Borthen, but have not been adopted by other operators to any considerable extent. Resection of the cervical sympathetic, done with success in some cases, has not proved superior to less serious measures and has fallen into disuse for the treatment of glaucoma.

In acute or congestive senile glaucoma, after an attempt for a day or so to relieve by medication, and also in the earliest stage of non-congestive glaucoma, before the iris has become adherent the writer does the classical **iridectomy**. In the presence of these conditions he prefers to establish a filtering cicatrix. Weeks (*Arch. Ophth.*, xlix, 316, 1920).

**Increased ocular tension in childhood** leads to distention of the eyeball: *Buphthalmos* or *hydrophthalmos*. The eye becomes visibly distended, especially the cornea. The pupil remains small; the eye is commonly myopic; vision deteriorates, and is likely to be entirely lost. In some cases **iridectomy** has seemed to check the course of the disease.

**Diminished tension of the eyeball** follows all perforating wounds, and continues with corneal fistula or cystoid cicatrix. It may also be caused by injuries that cause no wound of the ocular tunics, apparently by nerve influences. Softening of the eyeball commonly attends chronic cyclitis or iridocyclitis, in which connection it indicates serious intraocular changes.

Temporary softening of the eye attended by pain, photophobia, and deep hyperemia of the eyeball is called *ophthalmomalacia*. The attacks may last hours or days, and are liable



to recur. Rest of the eyes, hot applications, and weak solutions of eserine are indicated.

Injection of 0.2 to 0.4 c.c. (3 to 6 minims) of 1:1000 adrenalin in a weak solution of procaine under the conjunctiva near the cornea gave excellent results in chronic glaucoma. The injection did not have to be repeated for weeks, if eserine was used during the intervals. Adrenalin seems to reduce the intraocular tension. In acute glaucoma operation is preferable. C. Hamburger (Med. Klin., Mar. 2, 1924).

Just as effective as the injection of adrenalin is its insertion well under the upper lid with fine forceps to the amount of 4 to 8 minims (0.25 to 0.5 c.c.) on a small cotton pledget. The eye may or may not be anesthetized previously with a drop of butyn or phenacain. Reduction of intraocular tension is perceptible in 12 or more minutes. H. S. Gradle (Jour. Amer. Med. Assoc., Feb. 28, 1925).

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**GLUCOSE.**—Known also as dextrose, grape sugar or corn sugar, glucose is a simple monosaccharide,  $C_6H_{12}O_6$ , produced by the hydrolysis of starch. It should be noted that the official term *Glucosum* refers, not to dextrose alone, but to the syrupy type of commercial glucose or corn syrup, which contains, in addition, maltose, dextrins, and water. Glucose suitable for intravenous or other injections became official in U. S. P. X (1926) as *Dextrosum*, which is chemically  $C_6H_{12}O_6 + H_2O$ , and, being dextrorotatory, is sometimes termed dextro-glucose. One gram of dextrose, which occurs as a white crystalline powder or in white granules, is soluble in 1 c.c. of water and in 59 c.c. of alcohol. In watery solution it is neutral to litmus.

**MODES OF ADMINISTRATION AND DOSE.**—For medicinal purposes, dextrose is usually given intravenously, subcutaneously or by rectum. By the first-named route all concentrations up to 50 per cent. have been employed, the usual solutions ranging, however, from 5 to 15

per cent. Amounts up to 1000 c.c. (1 quart) of 10 or 15 per cent. solutions are frequently given. Any form of intravenous apparatus may be used for the purpose, and the solution must be given very slowly, the entire administration preferably occupying 90 minutes where a large amount is to be introduced. Insulin is sometimes combined with glucose, 1 unit of U20 insulin being used for every 2 grams of the sugar.

Subcutaneously a 10 per cent. solution in normal saline is suitable. By the rectum a 5 per cent. solution in normal saline is commonly used; by the drop method 1 quart or more of the solution may be introduced in 24 hours, provided the administration be discontinuous.

For either intravenous or subcutaneous use the solution should be sterilized, prepared only with C. P. dextrose, and buffer salts added to prevent "glucose shock," i.e., a chill and rise in temperature in  $\frac{1}{2}$  hour, followed by weakness and prostration. As recommended by Stoddard, a glucose solution should be autoclaved at 15 lbs. pressure for 20 minutes within 2 hours after it has been made up, and never used after it is 48 hours old. To the autoclaved solution is added 1 per cent. by volume of the following buffer solution: (a)  $NaH_2PO_4 + 2H_2O$ , 161.1 Gm.; water, to make 500 c.c. (b) NaOH sticks, 46 Gm.; water, to make 500 c.c. Close to 78 c.c. of (b) are required to be mixed with 100 c.c. of (a) to produce the required buffer solution of  $pH=7.5$ .

**THERAPEUTIC USES.**—As a nutrient, commercial glucose has been used by the mouth in cases of **undernutrition**. Bennett and Dodds have added it to the diet in amounts up to 1 pound or more daily in a mixture made up of glucose, 1 lb.; water, 1 qt.; lemons, 2, and laud this procedure as a means of securing a high-caloric, easily assimilable diet in non-diabetic cases, including those of **acute infections**.

Originally employed to a large degree for their diuretic action, subcutaneous and intravenous injections of dextrose have come into extensive use for the combined purposes of nutrition and prevention of acidosis in non-diabetics suffering from incessant vomiting or shock and in gastrointestinal disorders with or without inanition. Used preoperatively in acute sur-

gical conditions, they reduce the operative risk.

Some observers, notably Jørgensen and Plum, have found intravenous injection of doses as small as 20 Gm. (5 drams) distinctly beneficial in heart disease, the appetite, incidentally, being increased.

According to Weeks and Briggs (Cal. State Jour. of Med., Mar., 1922) a solution of glucose and sodium bicarbonate, 5 per cent. of each, is practically isotonic with the blood and readily absorbed from the rectum.

They recommend its use in dehydration and for all cases that cannot take fluids for 3 days or more. S.

**GLYCEMIA.**—This term should in reality be *glucemia*, for it is intended to mean an excess of glucose in the blood, i.e., over and above from 0.06 to 0.11 per cent., the normal amount. The belief that sugars and starches alone give rise to glucose is erroneous; proteins, on being split up during digestion, yield a non-nitrogenous moiety which is converted into glycogen. This is an important feature in the dietetic treatment of metabolic diseases.

In the body, however, there is, as shown by Lusk and his co-workers, a constant ratio between glucose (or dextrose) and nitrogen in the blood, the D:N ratio, which has been found to be 3.65:1. This has made it possible to estimate the severity of a given case. Thus, while waste nitrogen is excreted in the urine, the unused glucose in a diabetic also becomes a waste and is likewise excreted in the urine. Gradually, therefore, as the sugar excretion comes to approximate the D:N ratio, the more does it become evident that less and less sugar is being utilized, until the 3.65:1 is reached, when none is assimilated. Although this indicates a severe case, it does not mean an absolutely unfavorable prognosis, for many diabetics have lived long after this condition was reached, some even showing no sugar.

**Children.** The sugar content of the blood in infants was studied by Mertz (Arch. f. Kinderheilk., Oct. 16, 1920), who found that the carbohydrate metabolism of infants and young children obeys the same laws as in adults, and that it pre-

sents no special features. Efforts by Strouse (Arch. Internal Med., Dec. 15, 1920) to change blood sugar percentage of 5 normal persons by increased or reduced water intake and excretion failed. This indicates that for practical clinical purposes the blood sugar percentage method is accurate. Daily variations occurred in 5 normal persons. They seem to be influenced by changes in the weather.

The ingestion of sugar increases the glycemia, however, causing the so-called alimentary glycemia.

**Blood-Sugar Tests.** In a study of 4 different techniques applied to determine the sugar content of the blood in 35 specimens from 28 patients and healthy controls, with the parallel findings tabulated, Host-Hatlehol (Norsk Mag. f. Laegevidensk., Sept., 1920), found that the normal level seemed to be 0.11 per cent. with the Bang, Hagedorn and Folin tests, but that the Myers and Bailey modifications of the Lewis and Benedict method gave higher figures than this in 3 cases, up to 0.142 in 1 case. Various methods will be found described in the article on Diabetes, Vol. IV, pages 20 and 21, but they are all too complicated and take up too much time for the general practitioner. They are best carried out by clinical chemists.

**Clinical Applications.** Besides diabetes, to which the reader is referred, blood sugar tests have been elucidative in various disorders. Thus, in the course of experiments in animals and clinical observations in man, by the Bang micromethod, Chantaine (Zentralbl. f. innere Med., July 24, 1920) found that in ether narcosis there is an increase of blood sugar amounting to from one-third to one-half. In ethyl chloride anesthesia there is no hyperglycemia. After severe cerebral shock no hyperglycemia was manifest in animal experimentation. In diseases of the nervous system there was usually no evidence of it.

**GLYCERIN.**—Glycerin (*Glycerinum*, U. S. P.), sometimes called *glycerol*, is a colorless, syrupy liquid, of a sweet, warm taste. It is obtained by the saponification of fats. It is soluble in water and alcohol. Exposed to the air, it does not become rancid or

undergo fermentation, and it increases in weight on account of its great hygroscopic powers. Glycerin has decided antiseptic and solvent powers.

### PREPARATIONS AND DOSES.

—*Cataplasma kaolini*, N. F. (cataplasm of kaolin), used locally.

*Glycerinum*, U. S. P. (glycerin); dose, 10 to 120 minims.

*Glyceritum acidi tannici*, U. S. P. (glycerite of tannic acid); dose, 30 minims; also used locally.

*Glyceritum amyli*, U. S. P. (glycerite of starch), used locally.

*Glyceritum boroglycerini*, U. S. P. (glycerite of boroglycerin), used locally and as vehicle for phenol, chrysarobin, vegetable acids, etc.

*Glyceritum ferri, quinine, et strychnina phosphatum*, U. S. P. VIII. (glycerite of phosphates of iron, quinine, and strychnine); dose, 15 minims.

*Glyceritum hydrastis*, U. S. P. IX (glycerite of hydrastis); dose, 30 minims.

*Glyceritum phenolis*, U. S. P. (glycerite of phenol); dose, 5 minims.

*Glyceritum vitelli* (glycerite of egg yolk), used for emulsifying.

*Suppositoria glycerini*, U. S. P. (glycerin suppository).

### PHYSIOLOGICAL ACTION.—

Glycerin in the pure state is slightly irritating when applied locally to the skin or to the mucous membranes; it excites the secretions and causes an increased flow of blood to the parts; in some subjects it produces pain and decided irritation. The ingestion of glycerin causes no appreciable systemic effects. It sometimes acts as a laxative, but does not seem to affect digestion. Injected into the circulation in large amounts, glycerin causes convulsions, due to its hygroscopic powers. Although Pavy as-

serts that the ingestion of glycerin by diabetic patients increases the polyuria, others believe the contrary to be true, and find advantage in its use. The glycerin in stores other than responsible pharmacies is apt to contain arsenic. Vegetable glycerin should be preferred.

The bactericidal action of glycerin is quite manifest on pathogenic bacteria of various kinds.

**THERAPEUTICS.**—Good results have been obtained in the use of glycerin as a substitute for sugar in the sweetening agent diet for diabetes, but care must be taken that pure glycerin be administered.

**Constipation.**—In constipation the use of glycerin suppositories is followed by excellent results, but a too long continued use may produce rectal irritation. When suppositories are not available, or for any other reason, glycerin may be given by rectal injection, 1 to 4 drams (4 to 16 c.c.) being used. Seifert observed that 50 minims (3.3 c.c.) sufficient to produce a copious evacuation without leaving any disagreeable sensation. In no case did the drug lose its effect, though sometimes given regularly for many months. While toxemic symptoms or rashes may be produced by the use of ordinary enemata, none such have been observed in glycerin enemata. (Burford.)

Boas found that in patients with hemorrhoids, however, the insertion of any syringe may be productive of pain. Hollow suppositories of cacao butter may then be employed, each containing 15 minims (1 c.c.) of pure glycerin. This dose is sufficiently large, and acts in fifteen to twenty minutes. It is never necessary to use more than one suppository, though

there would be no objection to giving two.

J. P. Crozer Griffith also noted that occasionally a stinging sensation in the rectum attending the injection, or a burning sensation, lasting a few minutes after the bowels were opened. He found that this did not occur if the glycerin were mixed with a small quantity of water.

In acute **coryza** glycerin (1 part to 4 or 5 parts of water) may be used in spray or applied to the nares by a camel's-hair pencil. Diluted with equal parts of water, it is useful as a **mouth-wash**; it may be applied on a swab to relieve the dry mouth of **typhoid fever** or to facilitate the removal of **sordes**. If the sweet taste is objectionable Ringer recommends a mixture of equal parts of glycerin and lemon-juice. This is also useful in the last stages of chronic diseases, as **phthisis**, to relieve the dry, shiny condition of the mouth and tongue.

Glycerin is valuable as a lubricant, especially in the case of stomach-tubes, where its pleasant taste recommends its use.

*Glycerite of phenol* is a useful application to **foul-smelling ulcers** and **open sores**. *Glycerite of tannic acid* (containing 20 per cent. of tannic acid) is a useful application in **follicular tonsillitis** and **pharyngitis**. *Glycerite of starch* is used as a vehicle for cutaneous remedies and as a bland protection to superficial **abrasions** and irritated surfaces. *Glycerite of boro-glyceride*, an excellent dressing for **ulcers**, contused and lacerated **wounds**, etc., also does good service as a deple-  
tant to the cervix uteri, a tampon, being soaked in it, applied locally to the cervix and renewed daily. In **pelvic congestion** the application of

the tampons should be made two or three times daily, each application being preceded by a copious hot douching.

*Glycerite of egg-yolk*, or glycerin, besides being useful in preparing emulsions, is an excellent application for chapped hands or face. For this latter purpose glycerin, diluted with 1 to 3 parts of rose water or orange-flower water, is an elegant preparation. *Glycerite of hydrastis* is a soothing and alterative application to **unhealthy** and **sloughing sores**, old **leg-ulcers**, and **sloughing cancerous growths**.

**Genitourinary Disorders.**—**Renal calculus** has been treated with success by the ingestion of glycerin. The passage of the stones occurred in from six to thirty-six hours in 31 cases reported by Herrmann; in 21 cases there was subjective improvement, while in 33 the remedy proved quite inactive. Its action is ascribed to the elimination of the glycerin by the kidneys. The dose varies from 1½ to 4 ounces (45 to 120 c.c.), diluted with equal parts of water.

**Inflammatory and Septic Surgical Disorders.**—*Antiphlogistine* and its congeners—*cataplasma kaolini*, N. F., etc.,—are rather popular just now, and deservedly so, for they give relief in a large number of very diverse conditions. Probably in all cases the active therapeutic agency, according to L. Burges, is the hygroscopic power of glycerin. It is simply a method of applying to the surface the principle of the glycerin tampon, which has been so long in use for the relief of pelvic congestion or inflammation. They have their drawbacks, however. Serious burns have been produced by them. That, it may be

said, was the fault of the one who applied the dressing; but accidents will happen, and the difficulty lies in getting it off again quickly enough to prevent injury. Another consideration which often weighs against their use is that they are rather expensive.

Similar good results were obtained by Burges from the application of pure glycerin in localized and superficial inflammations of various kinds. In a case of **chronic eczema** of the leg, the application of a piece of lint soaked in glycerin yielded very satisfactory results. Likewise, in a case of deep **inflammation** of the **palm**, the use of a glycerin pad suitably covered with gutta-percha tissue and cotton-wool brought about prompt relief of pain and probably prevented abscess formation. In another patient with a similar condition of the flexor tendon sheath in one of the fingers, a glycerin dressing caused rapid improvement, avoiding the necessity for operation. In a patient suffering from a large **carbuncle** on the left temple the free application of glycerin on a piece of gamgee covered with gutta-percha subdued the inflammation, relieved the pain, previously severe, and led practically to recovery in a week. The author ascribes the beneficial effect of glycerin in this and other cases to its hygroscopic property. In the carbuncle case it led to a free discharge of serum from the inflamed area; a starch poultice was occasionally applied in order to remove the scaly film of dried serum which formed on the surface. Glycerin was also used successfully in a case of **mastitis**, one of **pleurisy**, and in minor inflammatory conditions, including a case of threatened **superficial gangrene** (diabetic) of the toes.

Rusca and Arndt have recently made systematic use of glycerin dressings in treating **infected wounds**, **phlegmonous inflammations**, **paronychia**, **adenitis**, and **furunculosis**, with excellent results. Glycerin, by absorbing water, decongests inflamed tissues, and tends to prevent suppuration and promote repair. Lucas-Championnière has recommended the following phenol-glycerin combination:—

℞ *Phenol*,  
*Glycerin*,  
of each . . . . 50 Gm. (1½ ounces).  
*Sterile water* . 1000 c.c. (1 quart).

This fluid should be used hot, and applied to the involved surfaces without preliminary cleansing irrigation of the latter.

Besnier advocates the use of the following mixture:—

℞ *Tannic acid* . . 0.1 Gm. (1½ grains).  
*Glycerin*,  
*Rose water*,  
of each . . . . 50 Gm. (1½ ounces).

In localized **hyperidrosis**, glycerin should always be included in the preparation prescribed, if the latter contains formaldehyde in high percentage.

In **nasopharyngeal affections** the application of glycerin is a well-known and effective measure. To it may be added tannic acid, sodium biborate, alum, a salicylate, or formaldehyde.

On many occasions, the glycerite of starch may be substituted for pure glycerin with advantage. Editorial (*Tribune médicale*, Feb., 1912; *N. Y. Med. Jour.*, June 1, 1912).

The writer obtained good results with the use of a mixture in equal parts of alcohol and glycerin as a moist dressing in cases where the ordinary dressings induce skin irritation, especially in children of the "exudative diathesis." The irritant properties of the alcohol are practically annulled by the glycerin, its local curative effects, however, remaining unimpaired. The dressing is applied in the usual manner, viz.,

gauze is saturated with the mixture, folded several times, carefully expressed, placed over the skin surface, and covered with some impermeable material and a layer of cotton-wool.

This measure was employed with marked success in cases of **lymphadenitis**, **mastitis**, **suppurative processes** in general, **inflammation in the umbilical region in the newborn**, etc. F. Dörken (*Semaine méd.*, Oct. 23, 1912).

Thirty to 50 Gm. (6 to 10 fluidrams) of glycerin daily by the mouth recommended in **scrofulosis**, **tuberculosis** and **anemia** as a form of stimulation treatment. Benefit from this measure had already been noted by Vetlesen in **pernicious anemia**. Magat (*Deut. med. Woch.*, Jan. 18, 1924).

In **postoperative bladder paresis** Baisch and Doderlein found that 20 c.c. (2½ drams) of a 2 per cent. boro-glyceride solution injected into the bladder brought on spontaneous urination in cases where catheterization would otherwise be necessary. The method, according to O. Franck, is almost infallible in both men and women, and avoids the use of the catheter. The solution, to the amount of 15 or 20 c.c. (½ to ¾ ounce), is simply injected with enough force to overcome the resistance of the sphincter and penetrate into the bladder. About 10 c.c. (¼ ounce) returns through the urethra, but the remainder is sufficient to induce evacuation of the bladder within twenty minutes at the most. The ability to void urine spontaneously continues in these cases without the necessity of a second injection. The method was also found, at least temporarily, useful in **bladder paralysis** of mechanical or nervous origin, including **stricture** and **prostatic enlargement**.

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## GLYCOSURIA.—DEFINITION.

—The evacuation of urine containing sugar in sufficient quantity to be revealed by the ordinary tests.

**SYMPTOMS.**—Glycosuria is a symptom occurring under various conditions and compatible with perfect health. Thus, L. C. Wadsworth reported the case of a man aged 25 who accidentally discovered the presence of sugar in his urine, and who had no symptoms whatever of diabetes, although he passed about 10 per cent. of sugar a day. He was the oldest of 11 children, and examination of the specimens from the other 10 showed high specific gravity and the presence of more or less sugar in all. They were all healthy and passed a normal quantity of urine. Transitory glycosuria does not give any morbid symptoms and is only revealed by examination of the urine.

As Garrod stated the matter, no sharp line can be drawn, therefore, between diabetic and non-diabetic glycosuria. A first type of non-diabetic glycosuria is that prematurely termed renal glycosuria. In this there is an excretion of a small daily amount of glucose in the urine, but there is no hyperglycemia; in fact, there may be a reduction in the sugar in the blood below the normal percentage. The most striking feature of this condition is the fact that the daily amount of sugar excreted in the urine is very constant and is not affected by an increased carbohydrate intake. It suggests the existence of an abnormal renal permeability to sugar, similar to the experimental phloroglucin glycosuria. A second type of non-diabetic glycosuria patients is found among the middle-aged, who occasionally pass sugar in their urine. In such there is probably an actual reduction in the carbohydrate tolerance, but it is so slight as to give rise to glycosuria only at those times when the patient has considerably overeaten of starches. This is known to be compatible with many years of life. There are other cases, ones which are true temporary glycosurias, in which the sugar tolerance becomes normal between glycosuric phases. Those cases of temporary glycosuria which are met with in the course of infections such as pneumonia, scarlatina, and secondary syphilis,

and associated with phlegmonous conditions, seem also to belong clinically to the group of non-diabetic glycosurias, though it may be that in such conditions there is some implication of the pancreas. If so, they are of the essential nature of true diabetes. Such is probably the case in mumps, the only infectious disease which is known to involve the pancreas. There seems to be excellent reason to regard the islands of Langerhans as probably the dominant, if not the only, controllers of carbohydrate metabolism. It can scarcely be doubted that the pancreas is subject to minor ailments, as are the salivary glands. Such minor lesions may be the causative factors in temporary glycosurias.

Hyperactivity of both the thyroid and pituitary glands, and possibly of the suprarenals, causes, at times, a non-diabetic glycosuria, due, probably, to a disturbance of the interrelation between these glands and the pancreas. Among other forms of non-diabetic glycosuria may be mentioned those from shock or excitement; disease of the brain; tuberculous meningitis, and many drugs and toxic substances.

The amount of sugar contained in the urine may be determined by various tests (*vide* DIABETES MELLITUS), of which Fehling's, Benedict's, Bang's and the fermentation methods are commonly preferred.

As noted by Hart, the presence of a slight glycosuria cannot be positively asserted on the strength of one test. The following tests in the following order are suitable in this connection: (a) Fehling's test; (b) phenylhydrazin test; (c) fermentations followed by Fehling's test. Many attempts to hide a persistent glycosuria by self-restricted diet may be detected by the routine use of tests for the acetone bodies. Certain patients with transient glycosuria may be perfectly good risks for life insurance.

In performing Trommer's test for sugar, the writer filters the urine, to which an excess of copper sulphate has been added. The earthy phosphates and undissolved cupric oxide are thus removed, and a clear blue solution remains, which can now be tested accurately with copper sulphate. By this method, detection of

0.4 to 0.2 per cent. of sugar is possible. Sauer (Münch. med. Woch., Mar. 7, 1916).

Tracing 150 persons rejected in life insurance examinations 5 to 16 years before because of glycosuria, the writer found that only about 30 per cent. of them had diabetes mellitus. The proper and sufficient procedure for diagnosis and prognosis is now the determination of the fasting blood sugar. Harmless glycosuria and diabetes cannot practically be differentiated by alimentary glycosuria tests. J. E. Holst (Acta med. Scandin., lxxiii, 1, 1925).

The glucose in non-diabetic glycosuria is unaccompanied by acetone bodies unless there are other causes for their presence, such as pregnancy and starvation. The glycosuria can be repeatedly shown present while the blood taken at the same time shows a normal sugar content. W. R. Campbell (Lancet, Mar. 14, 1925).

**ETIOLOGY.**—Glucose, or dextrose, is a constituent of normal urine, but it is present in too small a quantity to be discovered by the ordinary tests. By the aid of the phenylhydrazin test, however, the presence of a small amount of glucose may be revealed in every sample of urine. Pavy estimated the quantity of sugar formed in healthy urine to be 0.5 per mille. The quantity of sugar contained in the urine is dependent on the amount of sugar present in the blood. According to experiences of Pavy, normal blood contains 0.6 to 1 per mille of glucose; v. Noorden states that the urine will contain sugar enough to be revealed by the ordinary tests as soon as the amount of sugar in the blood exceeds 0.2 per cent. This may be obtained experimentally by ingestion of large quantities of sugar, and in this form of glycosuria—alimentary glycosuria—the variety of sugar in the urine is always identical with that ingested: By ingestion of dextrose, glycosuria, or dextrosuria, is caused; by the ingestion of lactose, lactosuria; saccharose, saccharosuria, etc.

The amount of sugar necessary to produce glycosuria in a healthy person has been found to be:—

Of dextrose, or glucose, more than 180 to 250 Gm.

Of saccharose, more than 200 Gm.

Of levulose, more than 200 Gm.

Of lactose, more than 120 Gm.

When the stomach is full even larger quantities can be absorbed without causing glycosuria. Alimentary glycosuria cannot be produced in healthy persons by ingestion of starch. Miura (*Zeits. f. Biol.*, B. 32) took one morning 1200 Gm. (40 ounces) of rice cooled in water containing 308 Gm. (10 ounces) of starch; he experienced no consecutive glycosuria.

According to Rosenfeld, physiological glycosuria can be differentiated from the pathological variety by the administration of a starch, such as that contained in white bread. It always causes an increase in the glucose in the urine of diabetics, but does not influence the sugar in normal cases.

In the urine of lying-in women lactose generally appears between the second and fourth days of lactation; it again disappears after a short time. When the secretion of milk is suddenly stopped large quantities of lactose are for some time excreted with the urine. Zuelzer administered sugar of milk to lying-in women and found that this substance is more easily eliminated in the puerperal state than in the normal state. Von Jaksch found that in women during gestation the administration of 100 Gm. (3½ ounces) of grape-sugar was followed by appearance of from 1 to 18 Gm. in the urine.

A positive reaction with Fehling's solution during pregnancy is usually due to lactosuria, or to transient, alimentary, or recurrent glycosuria. In such cases lactosuria is probably associated with premature activity of the breasts. If glycosuria in such cases is alimentary it may be disregarded. Otherwise it may be transient or recurrent, or may indicate true diabetes. Glycosuria, late in pregnancy, not exceeding 2 per cent., unaccompanied by symptoms is usually transient, but may persist to the end of pregnancy. It is usually of slight clinical significance, but the patient should be carefully watched. If much sugar is observed early in

pregnancy, it may be impossible to make a diagnosis until after delivery. The condition will then disappear in glycosuria cases, but persist in true diabetes. Pregnancy may occur in diabetic women, or diabetes may become manifest during pregnancy. Either complication is serious. Williams (*Amer. Jour. Med. Sci.*, Jan., 1909).

Among 2200 consecutive obstetrical cases, 88, or 4 per cent., gave a positive test for some form of sugar during pregnancy, labor, or the puerperium. A positive Fehling's during pregnancy is usually due to a lactosuria or alimentary glycosuria and rarely to renal diabetes. Cron (*Amer. Jour. Obstet. and Gynec.*, Dec., 1920).

In various diseases alimentary glycosuria is more easily produced than in health; this has been tried by giving small quantities of sugar (less than 150 Gm.—5 ounces—of glucose) to patients suffering from various diseases. The result of these experiences has been very unsatisfactory. Diseases of the brain, the spinal cord, the peripheral nerves, the muscles, and functional neuroses do not seem to predispose to alimentary glycosuria. According to Strümpell, glycosuria can be produced in a healthy man by giving a large quantity of glucose early in the morning, the stomach being empty. The quantity of glucose necessary to produce this effect varies from 4½ to 5 ounces (135 to 150 Gm.). It is necessary that this quantity be given all at once. The occurrence of this so-called alimentary glycosuria depends not only on the quantity of glucose taken, but also on the rapidity of absorption.

In cases of marasmus, anemia, cirrhosis of the liver, progressive muscular atrophy, and arteriosclerosis no diminished power of sugar destruction could be detected. But in cases of neurasthenia or traumatic neuroses there was a diminished power of sugar destruction, and glycosuria could be induced more readily than in health. In cases of habitual drinkers of large quantities of beer, glycosuria could be readily induced by 3, 2½, or even 1½ ounces (90, 75, or 45 Gm.) of grape-sugar. The same condition Strümpell discovered in some cases after the drinking of an ex-



cessive quantity of beer (2 quarts) rapidly. Alimentary glycosuria does not occur in all great beer-drinkers.

The glycosuria of elderly life is due, in many instances at least, to excessive carbohydrate feeding; this excess is usually confined to some special carbohydrates, sugar, and wheat starch; the early glycosuric of this class is often easily able to care for other carbohydrate foods; the harmful carbohydrates should be detected and eliminated from the food; those that can be assimilated should be determined and permitted; there is a specificity in the metabolism of carbohydrates, as there is in that of proteins; the presence of a small amount (0.5 to 2 per cent.) of sugar in the urine should not be regarded as a matter of trivial importance.

In many persons the capacity of assimilating carbohydrates is largely determined by the time of day when the food is taken. Glycosurics who cannot metabolize carbohydrates when taken for breakfast may dispose of 100 Gm. (32 ounces) of bread taken at a six o'clock dinner. Why this is true it is hard to say, unless it is due to the more hurried way in which many things, both foods and medicines, pass through the body when taken in the morning. To what extent this holds is not known, but it has been observed in many patients. V. C. Vaughan (N. Y. Med. Jour., Feb. 26, 1910).

*Transient glycosuria* has been observed after concussion of the brain and apoplexy. Higgins and Ogden carried on a study of 211 cases of head injuries to determine the frequency of traumatic glycosuria and its possible relations to the nature of the lesion. There were in the 211 cases 20 that presented glycosuria. They found that after head injury sugar may appear in the urine as early as six hours and disappear within twenty-four, the average time for its appearance, however, being from eight to twelve hours; for the disappearance of the same, from the fifth to the ninth day, and that a small proportion of the cases may exhibit a permanent

glycosuria from the date of injury to the head.

After reading the work of Redard, Hadke, and Kausch, the writer examined, in this regard, 50 cases of fracture. A large proportion showed glycosuria. The chief significance of these observations is in their pointing to shock or cerebrospinal concussion as the principal cause of the condition. Such ephemeral glycosuria does not seem to have any influence on the healing of the injury. Nevertheless, he would postpone operations that are not imperative until the disappearance of the sugar. The chances of non-union might otherwise be greatly increased. A. E. Halstead (Jour. Amer. Med. Assoc., Sept. 7, 1907).

In about 50 per cent. of fracture cases there is a spontaneous or alimentary glycosuria. It usually appears immediately or within a few days, and begins to decrease after 10 days. True traumatic diabetes does not appear until much later. Konjetzny (Mitt. a. d. Grenzgeb. d. Med. u. Chir., xxviii, 860, 1915).

On the basis of Crile's observation that lessening of glycosuria occurs in exophthalmic goiter after thyroidectomy, the writer performed subtotal thyroidectomy in 2 cases of glycosuria. After brief improvement, both died in coma. O'Day (N. Y. Med. Jour., Feb. 24, 1917).

Trivial conditions may sometimes cause glycosuria. Thus, Bazy reported a case of glycosuria in which death followed speedily after the passage of a sound employed to search for vesical calculus. Parry also reported a case which was due to the presence of numerous thread-worms in a child of 5 years. After expulsion of the worms by santonin the glycosuria disappeared and the child regained its former health.

Non-diabetic glycosuria may usually be connected with some antecedent condition, and disappear when this is removed. The amount of urinary sugar is always small, while the bulk of the urine is not increased. Again, diabetic diet exerts little or no influence. Diabetic glycosuria is

eminently chronic, is usually of much higher degree, and is accompanied by polyuria. Stern (Berl. klin. Woch., April 28, 1913).

The term *sapremic glycosuria* applied to a glycosuria of relatively slight degree attendant upon carbuncle, gangrene, or erysipelas, independently of any true diabetic symptoms. The sapremic products are the cause of the glycosuria. Higginson (Brit. Med. Jour., Feb. 26, 1921).

The writer distinguishes 2 kinds of sugar excretion in the urine: 1. Physiologic sugar excretion, which has no relation to the amount of glucose in the blood and which comprises sugars whose nature is not known, but which probably do not include glucose. After meals consisting of bread, as well as in urine that is concentrated, these physiologic sugars may occur in such quantities that the reduction reactions commonly employed are positive. 2. Pathologic sugar excretion, caused by the passage of the glucose of the blood into the urine when the blood sugar concentration exceeds the renal threshold. H. F. Host (Jour. of Metab. Research, Sept.-Oct., 1923).

In 37 normal persons examined for *physiologic glycosuria*, the author found a range of from 0.15 to 0.93 Gm. of glucose in the 24 hour urine. In women the average was 0.32 and in men, 0.45. The glucose excretion may be greater either at night or in the day-time. Zuckermann (Medicina, May, 1925).

Physical exercise under defective nutritional conditions may cause glycosuria.

The writer found that participation in a decisive football game caused it in 9 out of the 17 subjects; also in 6 of the 7 substitutes, and in 6 of the 13 spectators examined. It also occurred in 11 out of 27 first-year medical students given a short but difficult written examination. Hammett (Jour. Amer. Med. Assoc., May 6, 1916).

The modern conception of glycosuria takes into account the functions of the ductless glands (Blum, Sajous, Herter and

Wakeman, Lorand, and others). Excessive thyroid secretion tends to induce glycosuria, whereas hypothyroidism has the opposite effect. These effects are by no means constant and there may be no lowering of sugar tolerance in a severe case of Graves's disease. What has been said of the part played by the thyroid is equally applicable to that taken by alterations in the pituitary. Hyperglycemia and glycosuria are likely to be present in any disease which causes an excessive supply of epinephrin to the blood, and the evidence at hand suggests that the adrenal secretion may play the chief part in the regulation of the glucose content of the blood. The glycosuria of pregnancy has been ascribed to the well-known influence of this state upon the thyroid and pituitary.

According to P. L. Marsh (Jour. of Lab. and Clin. Med., July, 1924), by far the largest number of patients with glycosuria are suffering from endocrin disturbances. The condition is a common feature of hyperthyroidism and of exophthalmic goiter, and with patients presenting these syndromes hyperglycemia is the rule. Patients with acromegaly or pituitary gigantism frequently have glycosuria; these conditions are both believed due to hypersecretion of the hypophysis, and there is evidence that the glycosuria is due to hypersecretion of the posterior lobe. The secretion of the adrenals has recently become of clinical significance because it has been suggested as an antidote for insulin hypoglycemia. Adrenalin administered subcutaneously causes a discharge of glycogen from the liver into the blood, and in normal animals there may be sufficient hyperglycemia to cause glycosuria.

Glycosuria may also be due to poisoning by morphine, prussic acid, mineral acids, amyl nitrite, carbon monoxide, chloral-amide, nitrobenzol, ergot, etc.

Case with a glycosuria of 5 or 6 per cent. on an ordinary diet rich in carbohydrates, yet the patient felt perfectly well. These cases are best explained by assuming a low renal threshold for sugar. Cases in which the urine is regularly sugar-free in the morning but contains sugar in the course of the day are termed *cyclic glycosuria*.

the colored race exhibits less tendency to thyroid pathology than does the white race; men are less frequently affected than published figures indicate. No particular water supply was under suspicion. E. G. Jones (Trans. Amer. Med. Assoc.; Med. Rec., June 29, 1918).

During 2 months' examination of western drafted men by the writers, they were led to conclude that goiter was more common in young men than the experience of the general practitioner would suggest. Delinite goiter districts in Oregon and Montana and probably in Nevada were noted, locality appearing of much greater importance than family tendency. Most of the goiters in drafted men were distinctly toxic, the more toxic showing a tendency to nephritis, in addition to cardiac symptoms. Brendel and Helm (Arch. of Int. Med., Jan., 1919).

A study of the incidence of goiter in St. Louis and Chicago showed that 30 in every 1000, or 24,000 people, in St. Louis had some form of goiter. In Chicago it is estimated that 52 in every 1000, or 150,000 of the people, are goitrous, the total incidence being more than 6 times greater than in St. Louis. A comparison of the mortality records of St. Louis and Chicago showed that the proportion of deaths due to goiter to deaths from other causes was 6 times greater in St. Louis than in Chicago. The sex ratio of the disease was found to be 1 affected man to 6 affected women in Chicago and 1 to 9 in St. Louis. The race ratio as found among the cases reported in St. Louis was 1 colored patient to 9 white patients. Goiter seems to be most prevalent among persons between 20 and 30 years of age. In Chicago exophthalmic goiter was found to be the most common type and in St. Louis simple goiter predominated. Bess Lloyd (Ann. of Clin. Med., Oct., 1924).

A survey of 2329 children in the city of Winnipeg and several country points in Manitoba showed that there is a high incidence of goiter among these children, and there is an appar-

ent difference in the susceptibility of the various races, both in the total goitrous incidence and in the severity. Hamilton and McRae (Can. Med. Assoc. Jour., Oct., 1925).

Much etiological prominence has been attached to the influence of *altitude*, owing to the fact that Bircher's map of the distribution of goiter in Middle Europe indicates a predilection of the disease for mountainous districts. Its presence in flat countries, however, such as those stretching from the north of Paris toward Belgium, along the valley of the Thames, the low-lying districts of Ontario and Michigan, where cases are very frequent, and in the Chitral and Gilgit Valleys of India, where, according to McCarrison, goiter is endemic, tends greatly to diminish the importance of this cause.

The *water supply* has held a prominent place among the many causes of goiter vouchsafed. Kocher found that in the canton of Berne, Switzerland, there were actual goiter fountains which almost invariably produced goiter in the children who drank the water. On the other hand, in locations where goiter prevailed, families which received water from elsewhere avoided the disease.

Extensive experiments in dogs, rats, guinea-pigs, and monkeys in which enlargement of the thyroid followed ingestion of water from certain springs in regions where goiter is endemic. Goiter also developed when the residuum after filtration of such water was added to water from springs in goiter-free regions. Wilms (Deut. Zeit. f. Chir., Jan., 1910).

Goiter developed in 2 rats at Buenos Aires that were given exclusively water from a remote focus of endemic goiter. The water had been 5 days on the way. Houssay (Revista del Inst. Bact. de B. A., May, 1920).

Modern evidence seems clearly to show that certain agents ingested through the intermediary of water may cause the disease. Calcium has been incriminated by numerous writers, owing to the fact that in their experience goiter always coincided with the presence of an excess of this metal in the water consumed. Morris refers to a district in England in which the water is excessively rich in calcium, and in which goiter cases are correspondingly numerous, while the inhabitants who, in the same district, use rain water as sole beverage are free from the disease. The silicates, magnesia, alumina, iron, manganese, copper, lead, and other mineral constituents, have been regarded as possible causes. The more recent researches have tended to show, however, that these were but subsidiary factors.

To ascertain positively whether the richness of the water in lime salts, magnesium, and iodine contents caused the disease, the writer left ineffective water in contact with rocks from the streams of the goitrous areas. None of the animals using this water developed goiter except after long periods. He then put the struma-producing water in contact with Jurassic rocks, and no goiter was produced in the animals taking it. It thus appeared that the goitrous toxin was fixed by some rocks, *i.e.*, the rocks lose their efficacy just like the filter. The presence of colloid in goiter led him to try dialysis. The dialyzed portion gave no goiter to animals. The water remaining in the dialyzer produced it readily. Gouget (*Presse méd.*, p. 709, 1911).

All modern data speak against any special geologic formation as responsible for the development of goiter. The experiences of Chagas of Brazil in the study of the para-

sitic thyroiditides of that country, together with those of Gaylord in the United States in connection with endemic goiter in fishes, lead to the same inference as the findings of the authors, *i.e.*, that the exciting cause of goiter may be a micro-organism. Animals treated with goiter water develop an antiserum which yields reactions to the said water. This could be interpreted, of course, as due to fouling of the water in transport. Weichardt and Wolff (*Münch. med. Woch.*, Feb. 29, 1916).

Theodor Kocher long held that the prevalence of goiter depended upon the abundance of *organic matter in pathogenic waters* rather than upon the water itself, as obtained from its source. Waters has also emphasized the importance of organic rather than mineral agents as cause, at least as shown by his studies of goiter in India, where the rainy season (a time when organic matter is rapidly disseminated) is known greatly to increase the number of cases, even among white residents.

Some investigators have attempted to show, however, that water-borne agencies do not play a preponderating rôle in the genesis of the disease, as has been believed. Their evidence, however, is not convincing because the toxic agent or agents may have been introduced through the intermediary of contaminated foods or excrementitious matter.

Goiter is not known to occur spontaneously in rats at Zürich, but investigators have been able to induce it at will by taking the rats to the endemic foci, whether the animals were given the natural water to drink or the water was boiled for them, or they were not given any water or only water brought for them from Zürich. The research carried on with rats at 8 different endemic foci gave positive results in from 40 to 70 per

cent. of all the experiments. In the endemic foci the animals developed the goiter even when they were given only water from non-goitrous regions. Hygiene Institute at Zürich (Munch. med. Woch., Aug. 19, 1913).

In respect of simple goiter, certain districts have regarded themselves as essentially immune because of their geographic location. This is true of the Atlantic seaboard. But a survey of more than 11,000 children in New York City by the Division of Educational Hygiene of the Department of Education indicates an incidence of thyroid enlargement amounting to 20 per cent. among school girls of the metropolis. Such facts strongly suggest that the problem of goiter prophylaxis should not be overlooked in any place, however favorably it may appear to be situated. Large cities are centers of migration, which means environmental change for many of the population. Editorial (Jour. Amer. Med. Assoc., Oct. 17, 1925).

*Deficiency of the iodine content of foods* has increasingly, as will be shown in the section on Prophylaxis, asserted itself as a cause of endemic goiter both in Europe and in America. This applies not only to mountainous districts, but also to valleys and plains, the Great Lakes district, for instance, in the United States.

The writer concludes a comprehensive study of the prevalence of goiter in different regions and altitudes of Switzerland by the statement that goiter is a functional hypertrophy of the thyroid caused by the effort of the organism to make up a deficit in the iodine supply. As the iodine naturally is supplied in the food, goiter is prevalent in regions where the vegetation lacks the standard proportion of iodine. The main goiter regions were found by the writer at a moderate altitude, from 600 to 1000 meters. Above and below this, goiter is less prevalent. In 1 comparatively exempt canton he ascertained that the cooking salt used

had an unusually high iodine content. Hunziker (Corresp. bl. f. schweizer Aerzte, Feb. 23, 1918).

Goiter is present among the North American Indians, and the incidence of distribution is about parallel to that of the white population. The greatest exception is noticed in the Pacific Northwest, where the natural Indian diet contains more iodine (salmon) than does the white man's diet. Goiter is increasing among the Indians, and this increase seems to be explainable by 2 factors, iodine deficiency and toxic influences on the organism. These results seem to offer further support of the work by Marine and his co-workers and McClendon. Rush and Jones (Endocrinology, Sept.-Oct., 1925).

That goiter may be caused by a deficiency of iodine in the diet apparently was sustained by the investigations of the writers, based on the examination of more than 80,000 children and 135,000 recruits. The amount of iodine was determined in nearly 500 samples of soil obtained from all parts of New Zealand, together with samples of several waters from mineral springs and town supplies. Approximately, the incidence of the disease was inversely proportional to the amount of iodine in the soil. Again, where, even though the incidence of goiter was low, the amount of iodine in the soil was abnormally low, it was present in the water supply in greater amounts than usual, and the daily intake of iodine among the inhabitants of such a district was thereby maintained. Regions in which the average amount of soil iodine was low were those in which goiter was most frequently observed among domestic animals. The prophylactic treatment of school children in New Zealand by administering small amounts of iodine weekly gave fairly good results. Hercus, Benson and Carter (Jour. of Hygiene, Dec., 1925).

That the exciting cause is a *pathogenic organism or the toxin of such* has been urged by Poncet, Jaboulay

and Riviere, Klebs, Kocher, Lustig and Carle, Waters, and others. Kocher found that "goiter-water differs from goiter-free water in containing many more micro-organisms."

The disease is regarded by McCarrison as one in which the seat of infection is most probably the intestinal tract and of which the enlargement of the thyroid is the dominant symptom. These conclusions are based on the following facts: Goiter is caused by an organism invading the body of man. All the evidence so far accumulated points to the intestine as the seat of infection. In nature it lives in the soil of infected localities, and is very limited in its distribution. It is conveyed to man in the drinking-water, by contact with soil, or by other means yet undetermined. It requires a calcareous soil to enable it to flourish and produce goiter. It can be conveyed by man to places where the disease has not hitherto prevailed and, if the conditions are favorable there, it can produce the disease. The virus is, therefore, given off by persons suffering from the disease, in some way as yet undetermined, but not unlikely by means of the feces. The most susceptible individuals suffer most and first, namely, the children.

Goiter in Sanawar, India, was found by the author to be due to the presence of living micro-organisms in the water supplied to the children for drinking purposes. The disease can be eradicated, he holds, by the provision of a chemically and bacteriologically pure water. Most of the contamination in the water was derived from human fecal matter, *i.e.*, to a variety of colon bacillus. McCarrison (Indian Jour. of Med. Research, Jan., 1914).

Study of the endemic goiter conditions near Strasbourg showed that 40 per cent. of the school children had goiter, and that 66.4 per cent. of these children used water from wells. It was found also that 61 per cent. of the children lived on the ground floor. The writers urge the rôle which contact with contaminated soil plays in intestinal infestation. Parasites were found in the stools in 90 per cent. of the girls in the goiter district and only in 25 per cent. living elsewhere. These data point to a possible intestinal origin of goiter. Borrell, Boez and Freysz (C. r. Soc. de biol., Feb. 6, 1925).

A personal study of goiter in Switzerland, in 1894, led me to the conclusion that a prominent cause of goiter in that country was the habit of using *fresh feces* as fertilizing material for vegetables, even to the extent of voiding these excrementitious substances upon the snow during the winter, to facilitate their absorption by the soil when melting of the snow occurs.

In Bosnia, where goiter also prevails extensively, the filthy habits of the peasants who use their fingers to fish their food out of a common bowl is also traceable to fecal contamination and not contact as Kutschera believes. Suzuki produced enlargement of the thyroid in rats by feeding them with cooked rice mixed with rat feces, and also by injecting the latter subcutaneously. McCarrison observed the same result in animals which drank only water polluted with feces.

Localization of certain organisms, especially those belonging to the streptococcal group, in the thyroid gland, was found experimentally to be an important factor in the pathogenesis of goiter. Cantero (Surg., Gyn. and Obst., Jan., 1926).

Organisms of the *ameba* type, resembling the hematozoön of malaria, were thought by Waters (1897) to cause goiter. Grasset the following year found such a parasite in the blood of very recent cases. Chagas attributed a form of goiter met with in Brazil to *Conorhynchus megalus*, a biting insect, while Brumpt states that various insects, especially the bedbug, can act as hosts. Evidently, the causes of endemic goiter vary.

That *toxic products of metabolism*, an *excess of nucleins*, etc., can also produce goiter is suggested by many facts. Excessively nitrogenous foods were included by Munson (1895) among the causes of goiter, which he found to prevail to the extent of 2.36 per cent. among American Indians. Baumann noticed that flesh diet stimulated the thyroid in dogs to active hyperplasia. Marine found that in the trout the feeding of liver and heart produced goiter. Reid Hunt noticed the same result in white mice fed on liver.

The feeding of the highly artificial and incomplete diet of liver and heart muscle is the major factor in the causation of fish goiter, and the first essential in treatment is to provide some other food that meets the animal's requirements. A natural food of trout is fish and the experiments of the past two years show that when sea fish is fed to these trout existing goiter is cured and the development of goiter is wholly prevented. David Marine (Jour. of Exper. Med., Jan. 1, 1914).

Children are known to be more liable to the disease than adults, while, as stated by Kocher, "the female is more frequently the victim of goiter than the male."

The influence of *heredity* has been doubted, but this is unwarranted.

Many instances have been recorded. In a case reported by Schäffle, for example, the patient's brother and sister, mother, grandmother, great-grandmother, two aunts, and two grandaunts had goiter. E. E. Holland also described a family in which goiter occurred in five successive generations.

Congenital goiter may be due to the action on the fetal thyroid of toxic substances derived from the maternal intestine. These substances are the products of micro-organisms originating in fecally contaminated soil which are conveyed to man and animals by infected food and water. McCarrison (Indian Jour. of Med. Research, July, 1916).

As to the process engendered by these many causative agents, certain *bacteria and their toxins*, especially in the course of infectious diseases, may cause an inflammatory reaction, focal hemorrhages, etc., but in chronic goiters the pathogenic toxics, *all probably of bacterial origin*, first stimulate the organ to increased activity—a process that may be followed by degenerative changes which impair thyroid functional activity.

Chronic tonsillitis, catarrhal disorders of the nasal cavities and sinuses, gastroptosis and enteroptosis, by causing retention of fecal masses; chronic constipation in susceptible cases, and pregnancy owing to the excess of wastes added to those of the mother by the fetus, are all possible pathogenic factors individually or severally.

**Goiter due to Inherent Defensive Insufficiency of the Thyroid Apparatus.**—At the present writing (1926), the one-sided experimental methods which prevail in this country have caused a function of this mechanism

which dominates the whole problem of goiter and its complications to be neglected, to the great detriment of sufferers from this disease.

I refer to the participation of the thyroid and parathyroids in the defensive functions of the body, which I pointed out in 1903 in my work on "The Internal Secretions." It is not a direct antitoxic action of the thyro-parathyroid hormones which I claim for them, but an indirect one, an exacerbation of the familiar, catabolic properties now generally attributed to them. What I have urged for over two decades is that the thyro-iodase, activated by the parathyroid product, increases the lability of the phosphorus that all cells contain (and which I since identified as their lecithin), especially in their nuclei, and thus facilitates its oxidation by the blood's oxidizing substance (my adrenoxidase), which the tissue cells also receive through the red corpuscles. Heat being thus generated in excess, their tryptic enzyme is rendered correspondingly more active as a bactericidal or antitoxic agent. The thyroid apparatus thus becomes of major importance in the defensive or immunizing functions of the body at large.

As have all the functions which I attributed to the ductless glands over two decades ago alone stood the test of time, so has this defensive function. I do not mean, in this connection, the old detoxicatory rôle formerly attributed to the thyroid hormone and supposed to have a direct antitoxic action on the pathogenic substance, but the indirect function described above. The scope of the process was well defined by Swale Vincent, of London, when he wrote

recently in a review that the purpose of the thyroid product is "to prevent poisoning by products of metabolism" and also "by infection from without."

This accounts for my opposition to the prevailing tendency to remove the thyroid indiscriminately, *i.e.*, often where it might be preserved, thus reducing materially the patient's resources against disease.

In 1907 Lévi and de Rothschild, of Paris, wrote in the second volume of their "Physiopathology of the Thyroid Gland": Sajous has attributed, among the functions of the thyroid gland, a rôle to the latter which he assimilates to that of the opsonins, and to autoantitoxins. More recently, Miss Fassin, M. Stepanoff, and M. Marbé (Pasteur Institute) have confirmed on their side the influence of the thyroid on the blood's asset in alexins and opsonins. Lorand, referring also to the confirmation of my views by European investigators, states that they prove "the intimate relationship between the thyroid and our immunizing functions."

Col. R. McCarrison also wrote in 1913 (*Lancet*, Feb. 8): "The fact that the antitoxic and bactericidal resources of the body are largely dependent on the functional perfection of the thyro-parathyroid mechanism is, the writer believes, as clearly established as is the influence of this mechanism on metabolism."

"Sajous showed in 1903 that the injection of various bacterial toxins into man and the lower animals excited, more or less actively, according to their virulence, the thyroid gland's functional activity, while Bayon's researches show that the injection of bacterial toxins into the gland may lead to the actual formation of goiter. Farrant also has lately induced marked thyroid hyperplasia by the injection of diphtheria toxin into guinea-pigs; he demonstrated that the hyperplasia so induced could be controlled and greatly mitigated by the administration of thyroid extract at the same time as the toxin. Fassin found that the germicidal power of the blood was diminished by thyroidectomy. Charrin, Vincent, and Jolly drew attention to the fact that animals deprived of their thyroid glands are rendered



very susceptible to infectious diseases, to which they readily succumb. Hürthle observed that by ligaturing the bile-ducts in dogs the thyroid secretion was increased; he attributed this change to the passage of certain constituents of the bile into the blood. Turro has found that the juice of swine and sheep thyroids dissolved almost entirely the comma, typhoid and anthrax bacilli, as well as the *Bacillus coli communis* and streptococcus. Gley showed that the blood-serum of thyroidectomized dogs is more toxic than normal serum and gives rise to convulsions when injected into animals, while de Luca and d'Angerio have found that the urine of these animals contains a higher percentage of toxic substances than is normal, and that thyroid extract administered to them counteracted this toxicity.

"While making every allowance for errors of observation, these and other findings of a like nature justify the belief that the thyroid gland contributes largely to the body's antitoxic and bactericidal resources."

The manner in which the various forms of goiter, to be described, arise is readily understood when this antitoxic function of the thyro-parathyroid apparatus is taken into account. Briefly, we are dealing with excessive functional activity or abnormal effort on the part of the gland and its glandules to supply the excess of secretion *necessary to aid in destroying the toxic or toxins which have accumulated in the blood*. This abnormal functional activity is accompanied by more or less marked hyperemia of the organ, whose vascular channels are relatively enormous, and it enlarges—sufficiently at times to constitute a tumor, *i.e.*, a goiter.

Those who have investigated the coincidence of goiter and infection of the tonsils hold that in many cases diseased tonsils may be directly responsible for goiter, either simple or exophthalmic. Throat specialists should give particular attention to the state of the thyroid gland in all cases of in-

fecting tonsils, while practitioners treating thyroid disorders should bear in mind the possibility of an exciting factor in diseased tonsils. L. E. Brown (*Annals of Otol., Rhin. and Laryng.*, vol. xxxii, p. 367, 1923).

The thyroid is especially susceptible to many kinds of infection—from gums, tonsils, teeth, sinuses and blood, but particularly from a toxic condition of the intestines. In chronic intestinal stasis there is frequently a condition of intestinal putrefaction and autointoxication which causes an instability of the thyroid gland. Poisons in the blood may cause, first irritation, then glandular hypersecretion, later hypertrophy and finally atrophy and lessened function of the gland. W. S. Bainbridge (*Intern. Jour. of Med. and Surg.*, Apr., 1924).

Gaylord, McCarrison, Plummer and Pemberton emphasize infection as a causative agent. Many patients with exophthalmic goiters date their symptoms from some acute infection, and usually the removal of infected tonsils or other foci brings improvement. Closely allied is the auto-intoxication theory which assumes the existence of a specific infectious agent or at any rate of specific intestinal flora, the toxic products of which exert their mischief in the thyroid gland. The experiment of Marine and Lembart on fish would tend to advance at least the partial truth of this hypothesis. F. de Quervain emphasizes all intestinal infections as etiologic factors. W. L. Bowen (*Illinois Med. Jour.*, Nov., 1925).

The clinical meaning of this defensive process asserts itself particularly when the distinction between the non-toxic and toxic forms of goiter must be established to obtain satisfactory therapeutic results.

Not all thyroid glands (including their parathyroids) are functionally equal. A perfectly normal gland is able to fulfill its protective function in any kind of infection or intoxica-

tion without undergoing perceptible enlargement. But we know that morbid hereditary influences weaken this organ, as they do all others, and also that various infantile diseases, diphtheria for instance, tend to produce focal hemorrhages in the thyroid and parathyroids and to inhibit, seriously sometimes, their functional efficiency. Now, if either one of the various causes of goiter, the many kinds of intoxication enumerated, occurs in an individual possessed of such a *debilitated* gland the organ reacts, but insufficiently, so as to meet the needs of the moment. Though spurred on, it is unable to oppose successfully the toxemia, and, owing to this excessive and abnormal excitation (through the action of the poison on its centers), it swells, thus forming a goiter. Such goiters very rarely show hyperplasia or hypertrophy of the tissue elements, as long as they remain non-toxic, but only evidences of excessive functional activity, especially hyperemia.

The writer emphasizes the fact that simple endemic goiter is not a hypertrophy of the gland. It is essentially a degeneration. The enlargement of the gland in the earliest stages in which he was able to observe it consisted primarily in distension of the organ with colloid with atrophy of the epithelial elements. In this respect it differs entirely from the goiter of Graves's disease, in which the enlargement is due to an increase in the cellular elements of the gland. Sir James Berry (Lancet, Feb. 6, 1926).

Pathologists too easily overlook the teachings of physiology in their estimates and so complicate the whole picture of the disease by the multiplicity of classifications they introduce. Actual loss of life due to inability of the general practitioner

to identify the nature of the goiters encountered in practice can easily be traced to this cause, particularly since the promiscuous use of iodine has been revamped.

Most writers upon goiter have deemed it necessary to add to the already top-heavy and unilluminating nomenclature of the subject, until now the practitioner is overwhelmed and feels that it is hopeless for him to understand the subject. The writer urges that practitioners would do well to throw complicated terminology to the winds and content themselves with a simple classification. Hutton (Ill. Med. Jour., July, 1925).

Hence the adoption of Plummer's classification here into colloid, adenomatous and exophthalmic (Graves's) goiters. If to this is added the physiological teachings of over a half century's standing which we owe to Claude Bernard, that *any function is initiated and sustained by an increase of the arterial supply to the organ which carries on this function*, and recall the enormous volume of blood which is constantly passing through the organ—the blood of the whole body passing through it in one hour,—we obtain an idea of a fundamental principle which influences materially the whole conception of the morbid process. Briefly,

1. A thyroid apparatus being inadequate functionally to meet the defensive needs imposed upon it by any degree of intoxication which in normal individual calls forth a normal defensive reaction, there occurs,

2. More or less hyperemia of the organ to enhance its activity and defensive power, which in turn leads to more or less enlargement of the hypoactive organ, the structure of which normally recalls that of a sponge. This congestive swelling constitutes

the *simple colloid or parenchymatous goiter*.

3. If the causal toxemia be removed or the gland be assisted by adding a form of iodine which can be utilized by it or which counteracts the activity of the toxemia, the enlargement of the goiter tends to recede through reduction of its functional hyperemia.

4. If nothing is done to controvert the morbid process, the goiter persists, as a rule, as long as the toxemia continues, with, however, in a given proportion of cases, a tendency towards a gradual increase of secretory acini in the thyroid, and a corresponding increase of secretion follows.

5. When the increase of the thyroid hormones exceeds the needs of the defensive process, owing to intrinsic adenomatous hypertrophy, the excess of hormone produced, or the administration of iodine as a "remedial" measure, evokes toxic phenomena, thus constituting the *toxic adenomatous goiter*.

6. If the morbid process is permitted to proceed, the hyperemia and vasodilation in the thyroid apparatus persisting, a still graver condition results, that constituting *exophthalmic goiter or Graves's disease*, considered elsewhere in the present volume.

On the whole, the dominating pathogenic note of the active series of goiters—those other than goiters in which the tissues have undergone fibrous and other changes to a degree sufficient to annul their function—is the excess of arterial blood admitted to the organ to raise its functional activity to the standard required to enable it to meet the needs of any toxemia which may occur, focal or general.

Deficiency of iodine in a given district may in these circumstances cause goiter when the thyroid mechanism is normal; it is merely *relatively* deficient here; it cannot obtain from the local foods or beverages sufficient iodine to elaborate enough hormone. As we shall see, the recognition of this fact in Europe and in this country has led to invaluable results. This dearth of iodine does not exist everywhere, however, particularly in the East or West, close to sea-coasts. It is in such regions that the injudicious use of iodine has been fraught with untoward results.

There can be no doubt that we are seeing about us much misuse and overuse of iodine. It is being administered without discrimination in many cases for any swelling or fancied enlargement of the neck, no matter what the nature of the condition may be—exophthalmic goiter, goiter, simple colloid goiter, neoplasm, etc. Editorial (*Annals of Clin. Med.*, Feb., 1926).

Goiter in all of its active phases, including the adenomatous form which is now being generally relegated to the surgeon, is also amenable to *medical* treatment when the physiological hyperemia is taken into account. By judicious medication, as we shall see, and eliminating the causal toxemia, it does not become necessary to extirpate, even partially, an organ which fulfills so important a rôle in metabolism and immunity as does the thyroid apparatus.

Patient cited in whom operation had been resorted to twice and who also had been treated with the injection of boiling water, and yet died some years later with all the symptoms of acute thyrotoxicosis and evidence of proliferation of the thyroid gland. This case shows how little operative treatment gets at the cause of the proliferation

of thyroid tissue. Hoxie and Smith (Endocrinology, July, 1924).

**NON-TOXIC DIFFUSE COLLOID GOITER.**—In this form, characterized by an excess of colloid in the acini, the basal metabolism is usually below normal and all signs of hyperthyroidism are absent. It is often observed in young subjects of both sexes, but especially in girls, and is therefore also known in them as "adolescent" goiter. Judiciously treated, it invariably responds to medical treatment.

At the Mayo clinic no patient with diffuse colloid goiter was operated on during 1922. Boothby (Annals of Surgery, Nov., 1923).

**SYMPTOMS.**—In the typical colloid type the enlargement of the thyroid may be the first symptom noticed, and through, in males, as a rule, undue tightness of collars previously worn without discomfort. As the goiter develops, it remains soft and diffuse, showing, perhaps, a tendency to grow larger on one side, usually the right. If the case is examined carefully, however, symptoms of hypothyroidism may be discerned, some of which the patient will recall as antecedents of the goiter. Hypothermia is the rule, though rarely marked. Bradycardia is sometimes noted, and hyperidrosis, especially of the extremities may be complained of. The feet and hands are apt to be cold, and the patient may complain of rheumatic pains, particularly in the occipital region. The skin may be harsh and dry. In keeping with this symptom-complex of hypothyroidism, the urea excretion is more or less reduced, usually about one-third, and the basal metabolism rate more or less below normal as pre-

viously stated. There are no pressure phenomena, dyspnea, dysphagia, etc., unless the goiter is of long duration, *i.e.*, has been given time to assume the chronic type.

A normal basal metabolism was noted by the writers in puberty goiter. The administration of iodine had no characteristic effect on the metabolism, even in cases which had been clinically well influenced. The iodine salt was rapidly eliminated by the urine. Eckstein and Mommer (Zeitsch. f. Kinderh., Dec. 31, 1925).

The shape of the gland is not materially modified at first in this form, and any increase in size can only be discerned by palpation, though inspection may elicit a local enlargement during deep respiration, deglutition, and coughing, owing to the up-and-down movements of the growth. A colloid goiter grows in all directions, the two lobes meeting medially unless the isthmus takes part in the morbid process, as is frequently the case. The neighboring muscles are either raised or moved aside, according to their relative position. The growth also covers the trachea, but this canal is only compressed when one side of the growth becomes larger than the other, causing dyspnea. This is not severe in colloid goiters, as a rule, and is apt to occur only on exertion.

In marked cases a faint murmur may sometimes be detected with the stethoscope over the dilated blood-vessels, the latter projecting more or less from the surface in some cases, while the growth itself may be seen to pulsate. This suggests impending aggravation. Pain does not occur unless a local inflammatory process in the goiter, *i.e.*, strunitis (*q.v.*), is present. Unless the gland be in-

flamed or the growth be a malignant one (*q.v.*), it can be moved freely in the tissues surrounding it and from side to side.

**DIAGNOSIS.**—The diagnosis of colloid goiter is not difficult, particularly when the presence of dry skin, bradycardia, coarse hair and other signs of hypothyroidism are present in a child or during preadolescence. Such signs, however, are far from being always present. The total absence of tenderness or pain on pressure serves clearly to differentiate it from any acute inflammatory process, or from some forms of malignant growth (*q.v.*). The most important form from which it should be identified is the toxic adenoma, into which it may develop and which from my viewpoint is but a larval exophthalmic goiter. The tachycardia, tremor, high basal metabolism, etc., will readily point to the presence of the latter or of its precursor, a toxic adenoma.

**PROGNOSIS.**—In children an important feature in this connection is the initial cause. Thus, an apparently benign goiter attending or following an acute infection may indicate the presence in the gland of lesions, hemorrhagic, autolytic, etc., which may result in the reduction markedly of its functional efficiency and lead, through the formation of fibrous areas or other retrograde changes to infantile myxedema or even cretinism. The intelligence of a child may thus be seriously impaired through an infection involving the thyroid.

In practically all cases of colloid goiter recovery occurs,—spontaneously at times, a dangerous course to depend upon—under appropriate

treatment calculated to eliminate the primary cause and the resulting glandular congestion.

**PATHOLOGY.**—In this form there is little else than a uniform congestive enlargement with increase in the colloid content of the acini and with practically no modification of the acinal epithelium.

In the adult, however, the gland may become lobulated and nodular even though non-toxic, the presence of the goiter being the only annoyance complained of, though symptoms of toxicity may appear at any time. In such, besides the increase of colloid, flattening of the epithelium, possibly with an increase of interstitial cells, hemorrhagic foci or pseudocysts, is occasionally observed.

**TREATMENT.**—While a diffuse colloid goiter may disappear spontaneously, as is sometimes the case in adolescents, it is never safe to consider such a result as certain, as is too often done. Any pathogenic factor, dental, nasal, including the sinuses, faucial, gastric, intestinal, hepatic, biliary, genital, renal, etc., may so perpetuate the thyroid hyperemia as eventually to establish a chronic process and perhaps initiate hyperplastic goiter, *i.e.*, Graves's disease. The tendency to such complications is especially marked when a colloid goiter occurs in an adult. The first step, therefore, in all cases, is to ascertain whether any of the foregoing or any other disorder is present which through any form of intoxication may provoke a defensive reaction on the part of the thyroid.

The causal factor being eliminated, the goiter tends to recede and, if not of long duration, to disappear. This is especially where a focus of infec-

tion in the tonsils or peridental abscesses had been its primary cause. In adolescents, however, such clear etiological factors cannot always be discerned, the cause in some of them being an accumulation of wastes incident upon the transition period during which the functions of the thymus overlap those of the oncoming adult metabolic activities—a temporary state of things.

The diet is an important factor in this connection, flesh foods favoring the development of the goiter, as clearly shown by experiments in animals and clinical observation. Fish and fowl are allowable, however, while vegetables and fruit actually favor recovery. We have seen that hyperemia is an important feature of the goitrous process; hence, coffee, tea and other agents which tend to raise the general blood-pressure are contraindicated.

In districts where contaminated waters are known to be the primary cause, no water should be used as beverage or for cooking or to wash edible foods, salads, fruits, etc., that has not been thoroughly boiled. Or, waters from known contaminated areas should at least not be used as beverage. Marine and Kimball have found *sodium iodide*, 3 grains (0.2 Gm.) daily for a few weeks, prophylactic in children; the same measure will prevent development of a goiter in persons who migrate to districts such as the Midwest, in which iodine is deemed deficient owing to distant location from oceans or other salt water bodies.

The medical treatment, even in the simple colloid goiters, should have two objects: (1) that of increasing the defensive efficiency of the thyroid

apparatus, and (2) that of promoting constriction of the arterioles which govern the volume of blood which enters the organ.

**Iodine** has been the sheet anchor for the treatment of goiter for over a century. Although this halogen was discovered in 1812, in fact, burnt sponge, which is rich in this halogen, had been the main remedy for goiter many centuries. Its mode of action suggests itself: it enhances directly or indirectly the antitoxic function of the body at large through the thyroid apparatus or its secretion in the blood-stream, and thus aids in breaking down the causative toxic. As this relieves the thyroid gland of the excessive activity which causes it to enlarge, it recedes.

The **iodine** treatment and thyroid extract should be reserved for the cases free from stenosis, the goiter not growing rapidly, and the symptoms indicating *deficient thyroid functioning*. Here a rational and specific internal treatment gives as brilliant results as surgical treatment. T. Kocher (Deut. med. Woch., July 11, 1912).

The salt of iodine most used is **sodium iodide**, the potassium salt being harmful to the heart, owing to the action of the potassium ion on this organ. In appropriate cases, however, it should not be given in too small doses, except as test, since these only serve to enhance tissue metabolism and fail to promote antitoxin. A dose of 5 grains (0.3 Gm.) may be given night and morning. If taken in the midst of a meal, dissolved in a small tumblerful of water, it is well borne. The dose may be gradually increased until 10 grains (0.6 Gm.) are taken twice daily. The case should be carefully watched, and if

any sign of iodism appears the use of the iodide should be discontinued temporarily and the smaller doses resumed.

Iodism may sometimes be prevented by administering, besides the iodide salt, arsenic in the form of **Fowler's solution**, beginning with 2 minims (0.12 c.c.) twice daily in a half-glassful of water.

We have in desiccated **thyroid gland**, however, a far better and more reliable agent, the iodides being only used today where organic products cannot be obtained. Over twenty years ago, I pointed out that the iodine in organic combination which constituted the active agent of the thyroid gland included a catalytic oxidizing enzyme and termed it, therefore, *thyroidase*. Kendall, several years later, also discerned this property and termed the product he isolated *thyroxin*, which also betokens the presence of a catalytic oxydase. In keeping with other observers, however, I have not found thyroxin satisfactory in the treatment of goiter, but the desiccated thyroid gland, embodying as it does the catalytic oxidase, proved more satisfactory than any preparation of iodine, which is not a catalytic. In doses of  $\frac{1}{8}$  to  $\frac{1}{2}$  grain (0.008 to 0.03 Gm.), thrice daily, desiccated thyroid, if a fresh product can be obtained, is a satisfactory agent to promote the anti-toxic function in colloid goiter cases.

The vascular engorgement is overcome more rapidly if agents which promote constriction of the arterioles of the enlarged gland are administered simultaneously. The best of these are **ergotin** and the **posterior pituitary body** which, as is well known, contains adrenalin. The following

formula, given while the pathogenic focus, if any, is being eliminated, sometimes proves rapidly effective:

**R** *Thyroidei* ..... gr.  $\frac{1}{4}$  (0.016 Gm.).  
*Ergotinae* ..... gr. j (0.065 Gm.).  
*Pituitarii* ..... gr.  $\frac{1}{10}$  (0.0065 Gm.).

M. et fiat caps. No. j.

Sig.: One capsule three times daily.

To enhance the action of these agents 4 per cent. **iodine ointment**, prepared fresh, or a 5 to 10 per cent. oily preparation such as the **petroxolinum iodi**, N. F. (10 per cent.), should be rubbed over the gland daily, ceasing as soon as iodism or irritation of the skin appears. A piece as large as a small hazelnut suffices if properly rubbed in.

An **ointment of biniodide of mercury**, a piece as big as a pea being rubbed into the goiter daily, favors its reduction.

In some cases all the foregoing measures fail. This is because the causative toxemia is perpetuated.

Where goiter is endemic, the toxic is probably a water-borne one, mineral or organic. Investigations have, we have seen, emphasized the influence of micro-organisms (Kocher, McCarrison, and others), fecal pollution (Sajous, Susuki), and other contaminating agents. A **change of the water** used as beverage, cooking, etc., then becomes an essential feature of the treatment. A diet rich in meats is also an indirect cause (Waters, Baumann) of goiter; liver, for instance, is known to produce goiter in mice and trout (Reid Hunt, Marine) when fed to them. A **meat-free diet**, to prevent any intestinal autointoxication it might sustain, is at times very helpful. The intestines should be kept open by **saline aperients**, preferably **sodium phosphate**, 2 drams (8

Gm.) daily, and if any autointoxication of intestinal origin is clearly discernible, or if pathogenic organisms or entozoa in the alimentary tract be a possible cause, intestinal antiseptics: **thymol**, **betanaphthol**, **salicylate of sodium**, or **creosote carbonate**, should be administered.

In recruits suffering from parenchymatous goiter, which is extremely common at Basel, the writer obtained distinct reduction by giving 2 Gm. (30 grains) of **salol** a day, but only in simple follicular enlargement and parenchymatous goiter. The benefit obtained from mild continuous purgation and disinfection sustains the theory of parasites in the drinking water as the cause of goiter. Messerli (*Revue Méd. de la Suisse Rom.*, Dec., 1915).

The X-rays are advocated by some authors in all forms of goiter, but their use is contraindicated in adolescents, the tendency in colloid goiter being to reduce the functional activity of the gland which is already deficient. **Galvanism**—the electrodes being applied, one, the cathode, with its sponge wet with a solution of **sodium iodide** over the thyroid, and the anode wet with saline solution on the nape of the neck—sometimes proves efficient as an adjuvant, 8 milliamperes sufficing.

Various **pressure** devices have been tried but without clearly defined satisfactory results, while objectionable owing to the dyspnea which compression of the underlying trachea may produce. **Adhesive plaster**, if not caused to encircle the neck, and **flexible collodion** are the best borne, though in my experience ineffectual.

**TOXIC ADENOMATOUS GOITER.**—It is now generally believed that toxic adenomata invariably demand surgery, but this is due to the

fact that the influence of the circulation upon the development and regression of these growths is overlooked. These glandular masses are stated to be encapsulated, whether one or several be present; but such is not invariably the case. They are said to be isolated masses, but they are not, receiving, as they do, blood-vessels which are known frequently to cause hemorrhages. They are often said to be found in cretinism and myxedema and to cause in goiter cases the toxic phenomena of hyperthyroidism; but such symptoms are not present in myxedema or cretinism in which the symptomatology is all of the hypothyroid type. Some state that adenomatous tissue yields thyroxin; others state that it does not yield a normal secretion. The origin of the adenomatous growths is quite as unsettled. While they develop from colloid goiters, they are believed by some to develop from embryonic rests, but are, as formerly thought by others to be, pure adenomas, *i.e.*, developed from glandular tissue.

On the whole, the entire foundation upon which surgeons base their opinion that surgery is always indicated in toxic adenomatous goiters cannot stand even superficial scrutiny—any more, in fact, than the so-called medical treatment methods which they deem, quite appropriately, ineffectual.

Basing his conclusions on an observation of upward of 6000 goiters, the writer holds that the chief difficulty in the classification of goiters is the loose manner in which terms are used. The favored classification is into two general groups, the adenomas and Graves's disease. Both are much confused designations. The adenoma group is made to include the old lobulated colloids, with little or no new



gland formation, and the encapsulated, embryonal rests, which most often exist as independent single nodules or may be scattered about in the old colloids. Surgeons seem to think that the nodulations in the irregular old goiters are made up of nodules of fetal adenomas. Nothing is farther from the truth. They are nothing but old colloids, some areas of which have collected colloid more rapidly than others. A. E. Hertzler (*Am. Jour. of Surg.*, Sept., 1925).

Control of the circulation in these tumors after eliminating causal factors, focal infections, neurotoxic agencies, etc., with appropriate medical and other measures enables us, as we shall see, to preserve the gland in the vast majority of cases.

**SYMPTOMS.**—As Plummer has so well interpreted their cause, the symptoms of adenomatous goiter with hyperthyroidism can be produced by the administration of an excess of thyroid extract or thyroxin; therefore, he regards the toxic form of goiter as due "to the presence in the body of an excess of normal thyroid secretion." This raises the basal metabolic rate.

Hyperthyroidism is the physiologic status of an individual otherwise normal when the thyroxin in the tissues is sufficient to hold the *basal metabolism* above normal. Plummer (*Jour. Amer. Med. Assoc.*, July 23, 1921).

The basal metabolic rate both in diagnosis and treatment should not be depended upon unreservedly, however, but considered in conjunction with the clinical manifestations and the case history. An increase of thyroxin secretion is followed by an early rise in the rate, which occurs before the clinical symptoms are manifest. Its height is not as important as its course and the rapidity with which it changes. A rapidly rising rate, or one higher than the symptoms would indicate, usually means a rapidly secreting thy-

roid gland and greater severity than is seen with a slowly rising rate, or a rate followed closely by the clinical manifestations. Rapid absorption following massage or surgical intervention must be excluded. A stationary rate after a rise usually means that the disease has reached the zenith. A falling rate does not follow the activity of the thyroid as closely as the rising rate, and neither is it followed as closely by the symptoms. The variation between the falling rate and the symptoms is indicative of the intensity of the disease. The more severe the disease, the greater the variation. A fluctuating rate after an attack of thyrotoxicosis indicates pathological activity in the thyroid, and exacerbations of more or less severe grade are to be expected. J. E. Else (*Northwest Med.*, Apr., 1922).

The symptomatology of toxic goiter is not always based on the enforced exacerbant activity of a primarily debilitated gland, as in simple diffuse goiter which becomes toxic, but a gland which was normal when a toxemia,—which includes that due to toxic wastes evoked by shock plus the hypersensitiveness of endocrine centers incident thereto—intervened. Whatever the origin of the toxic type, the symptoms are similar, and the direct primary cause of the goiter and its toxic effects are the result of the excess of blood which it, the organ, receives.

Briefly, the primary etiological factor and the toxic phenomena give rise to hyperemia of the gland. The symptomatology of toxic goiter may, therefore, be divided into three classes which occur in logical sequence.

1. *Symptoms due to hyperemia of the thyroid.* The goiter is usually large and more or less uniform, though in many instances showing some pre-

dilation for the right side. It is generally firm and resists pressure, and the vascular engorgement being general, pressure effects, either in the neck itself through compression of the underlying trachea, or in the larger vessels and the nerves, are not uncommonly complained of, particularly when the patient is lying on his back. Exercise, fatigue, by increasing the catabolic wastes in the blood, overwork in adults, too strenuous athletic sports in school, especially in girls, thus promote the development of goiter and perpetuate it if present.

Hemorrhages are not infrequently found in toxic adenomas. According to Delamers and Terry (Ill. Med. Jour., July, 1925), this is due to thinning of the muscular and inner elastic coats and loss of the adventitia of the arteries after these vessels penetrate the capsule. The venous channels are particularly fragile. While the arteries were able to stand 250 mm. Hg, the veins ruptured when 100 mm. Hg was reached. Yet we must not overlook the fact that endocrine organs are not supplied with vessels similar to those elsewhere in the body; they are usually sinusoidal in the secretory elements of the gland, to facilitate functional activity. We know also that the thyroid, as are the adrenals, is particularly liable to the formation of hemorrhagic foci, particularly in the course of the diseases of childhood, diphtheria, scarlatina, etc. What these lesions emphasize therefore in toxic goiters is the importance of high vascular tension in the pathogenesis and symptomatology.

Capillary dilatation, especially marked over the upper part of the sternum, dermatographia, cutaneous hy-

peremia with unusual heat of the surface and congestive hyperesthesia of the goiter, a murmur in the latter when the stethoscope is used, all bespeak marked activity of the circulatory process within the gland and the body at large.

Exophthalmos from the same cause is occasionally observed and is usually slight.

*Symptoms due to the Excess of Thyroid Secretion.*—As I pointed out in 1903, the thyroid hormone serves to activate thermogenesis and metabolism by increasing the lability of the tissue phosphorus in the body at large.

Especially influenced in this connection is the entire *nervous system*: cerebrospinal and peripheral, owing to the wealth of this tissue in the phospholipoid lecithin. Hence the excitability and restlessness of the patient, even though less marked than in Graves's disease. This applies also to the tremor occasionally observed. Excitability of the basal nuclear centers, all rich in lecithin, accounts for the hyperexcitability of the whole sympathetic system, including particularly its cardiac branches. This is the main source of the *tachycardia*, which usually attains about 120 in toxic adenoma.

As regards the *heart proper*, myocardial lesions are said to occur through excessive activation of nervous origin. But though rare, these are due, from my viewpoint, to hydrolytic degeneration of the cardiac musculature, the enzymes of their cells acquiring excessive proteolytic activity as a result of the supranormal thermogenesis provoked by the excess of thyroiodase, the thyroid hormone. Irrespective of such lesions, the phenomena observed are

those of overwork; dilatation and compensative hypertrophy.

The heart may retain its normal rhythm even though dilatation occur; or it may become arrhythmic and show auricular fibrillation, which tend further to promote dilatation and the tendency to failure.

Studying 250 toxic adenomas of the thyroid, the writer found in the cases with hyperthyroid symptoms cell changes differing only in degree from those in exophthalmic goiter, while in the cases without such symptoms and with basal metabolic rates within 10 points of normal, an absence of cell hypertrophy and hyperplasia in almost all instances was observed. Secretion of a substance responsible for the symptoms and high metabolic rate seemed to be suggested by his findings. L. B. Wilson (Jour. Mich. State Med. Soc., Sept., 1922).

A study of the effects of the thyroid disease on the heart at the Mayo Clinic led the writer to ascribe the excess of thyroid secretion to 2 fundamental reactions: (1) Elevation of basal metabolic rate which increases cardiac work, causing acceleration of rate as well as increased output at each beat, and leading to hypertrophy and dilatation of the heart. (2) A cellular effect on the heart resulting in degeneration of the myocardium, soon associated with muscular fatigue. One of 2 subsidiary reactions then occurs. The heart may remain rhythmic and further hypertrophy and dilatation occur, which may end in heart failure. Or, arrhythmia, usually auricular fibrillation, may set in, resulting in circulatory slowing which favors further cardiac dilatation and failure. Auricular fibrillation was found at the first examination in 7 per cent. of patients with exophthalmic goiter and in 9 per cent. of those with hyperfunctioning adenoma. Willius (Ann. of Clin. Med., Jan., 1923).

In the definitely toxic cases significant heart changes were found in about 35 per cent. The first is *auricular*

*fibrillation*. This is at first transient, but tends to become established if the hyperthyroidism remains unchecked. If the hyperthyroidism is relieved during the stage of transient attacks, the condition permanently disappears in nearly every case. Similarly, in many patients in the clinical stage of established auricular fibrillation, normal rhythm returns permanently. In 900 cases of thyroid disease with some degree of toxicity the author found 50 with signs of true congestive heart failure due to hyperthyroidism. With very few exceptions, the histories of these 50 cases showed predominance of symptoms referable to the heart from early in the course of the disease. This agrees with the clinically recognized selective action of hyperthyroidism for certain hearts. Many of these cases are diagnosed and treated for a long period as cardiac cases, the underlying hyperthyroidism being overlooked. R. E. Hamilton (Jour. Amer. Med. Assoc., Aug. 9, 1924).

In cases showing high basal metabolic rate there is gradual loss of weight and strength owing to the excessive tissue catabolism, with increased appetite to compensate for the abnormal utilization of proteins and fat.

Examination of 190 patients with thyroid disease at St. Thomas's Hospital, London, sustained the view that the female basal metabolic rate is normally about 7 per cent. lower than that of the male, but that the female is the more efficient machine. There is general agreement that the increase during pregnancy represents the sum of the metabolism of mother and child, and that there is no variation in the mother, and the majority of investigators have found no change during menstruation, though it may perhaps occur in some women. The thyrotoxic patient is a most inefficient machine, and requires nearly twice as many calories to perform the same amount of work as a normal person,

and accordingly large diets and rest are needed in patients with exophthalmic goiter. The writer quotes the work of Boothby and others at the Mayo Clinic, who found that on a diet averaging 5245 calories over 17 days there were 699 calories a day unaccounted for after making the most liberal allowances for all energy outputs. The nitrogen metabolism was normal and protein food exerted its ordinary specific dynamic action. The increase in metabolism may reach 100 per cent. above the normal; 15 per cent. to 25 per cent. above normal may be considered mild and above 50 per cent. severe. F. S. Hansman (Med. Jour. of Austral., Aug. 22, 1925).

Acne, particularly marked over the shoulder blades, is sometimes observed, due to cutaneous efforts at elimination.

The kidneys are also involved at times, the specific gravity, the excretion of urea and phosphates being above normal, while more or less polyuria may be complained of. An important feature to remember when treatment will be considered is that the tissue lecithins chiefly are destroyed.

The researches of the writer have shown that the adrenals (from products brought to them by certain leucocytes) synthesize the adrenoxin, lecithin and cholesterol they secrete. The red corpuscles while passing through the adrenals appropriate these thermogenic agents and, after passing through the lungs to have their adrenoxin take up the oxygen from the air, proceed to the tissue cells. The secretion of the thyroid gland increases the lability or sensitiveness of the lecithin phosphorus to oxidation and thus enhances thermogenesis correspondingly. C. E. de M. Sajous (Endocrinology, Nov.-Dec., 1925).

The *blood-pressure* is, as a rule, not commensurate with the basal metabolism. In fact, while the latter may

be high, say + 50, the blood-pressure may be but 120 systolic, in a middle aged adult. This is due to the fact that the excessive catabolism induced by the excess of thyroiodase in the blood causes not only relaxation of the vascular tree but also relaxation of the cardiac muscle, especially the right ventricle.

In 138 observations on thyroid cases, the writers found that increase of *pulse pressure* is characteristic of hyperthyroidism. Diminution of pulse pressure is characteristic of uncomplicated hypothyroidism. Pulse pressure and basal metabolic rate, therefore, vary in the same direction. Analysis of the findings in the 150 observations on pulse pressure and basal metabolic rate showed a considerable degree of correlation between these 2 phenomena in cases of normal and disordered thyroid function. Davies and Eason (Quart. Jour. of Med., Oct., 1924).

**DIAGNOSIS.**—The onset of a toxic adenoma is usually insidious, dating back, in many cases, many years. While in diffuse colloid goiter the basal metabolism is not persistently elevated and is usually below normal, in toxic adenoma and exophthalmic goiter (Graves's disease), it is over 20 per cent. above normal. In toxic adenoma iodine and all its preparations are absolutely contraindicated, stimulating rather than inhibiting hyperfunction. The same effect is sometimes observed, however, in diffuse non-toxic colloids.

The writers studied 84 cases in which the diagnosis was difficult and the method and results of treatment in consequence uncertain. Of the total, 24 were found extremely sensitive to iodine, daily doses of 10 mgm. ( $\frac{3}{8}$  grain) intensifying every symptom of hyperthyroidism and increasing the basal metabolic rate. O. P. Kimball (Ohio State Med. Jour., July, 1924).

In exophthalmic goiter, the characteristic exophthalmos, the typical eye symptoms and gastrointestinal crises, the active and peculiar nervous and mental phenomena, with the high metabolic rate, the marked tachycardia often uninfluenced by sleep, marked hypotension, the ubiquitous tremor, with also the rapid emaciation will serve as distinguishing features.

Various specific tests have been introduced by as many investigators, but none can be said to have proved reliable in the present connection.

Neither the *digitalis*, *complement fixation*, *hyperglycemia*, *pituitary*, *quinine*, nor *adrenalin* tests have proven sufficiently certain to warrant unreserved clinical use, according to the writer. The *adrenalin* (Goetsch) test as a pathognomonic test leads to great error; in tests on normal medical students and convalescent ward patients, a sensitiveness to adrenalin was found in about 30 per cent. The sensitiveness appears to be independent of the thyroid gland. H. T. Hyman (Jour. Amer. Med. Assoc., Oct. 22, 1922).

Enlargement of the thyroid area and the pressure symptoms sometimes observed in adenomas are not pathognomonic of goiter unless the other symptoms recited are also present.

In some countries, Italy for example, enlargement of the thyroid in pregnancy is commonly observed.

Tumors of the mediastinum, enlarged lymphatic nodes compressing the trachea, and aneurysm of the aorta simulate the effects of a thyroid sufficiently enlarged, particularly if it is in part intrathoracic. Dyspnea especially on exertion is common to all these conditions. Two resources are helpful in this connection, however,

the up and down movement of the trachea on swallowing, and the fluoroscope to ascertain the location and outline of the compressing mass.

Various tumors of the thyroid may also simulate goiter. These will be considered later.

**ETIOLOGY.**—From the practical standpoint it seems best, for the present at least, to regard the thyroid gland in many instances of toxic goiter as a defensive organ the activity of which is raised, directly or indirectly, to a high pitch in the presence of some variety of etiologic factor, mainly toxic. The power of infectious or other toxic states to initiate the disturbances in both adenomatous and exophthalmic goiter is being increasingly forced upon our attention.

Even the cases brought on by intense emotional stress, grief, fright, as in the case of accidents, anxiety, etc., as I pointed many years ago, are due to the appearance of toxic wastes of central nervous origin, phosphoric acid among them, which actively stimulate the thyroid apparatus. The thyroid hormone which is then produced in excess, taking part in tissue catabolism, further excites the nervous elements already harmed by the emotional stress and we thus have a vicious circle which accounts for the severity of such cases. I have seen all the morbid symptoms of cured cases reappear under such circumstances. Apparently the etiologic factors of hyperthyroidism are much the same as those of exophthalmic goiter.

Toxemia, either chemical or bacterial, is almost always the cause of thyroid hypersecretion. Acute febrile infections frequently initiate hyperthyroidism. Chronic foci of infection are

likewise often responsible. The author recognizes also a toxemia of psycho-neurotic origin, *i.e.*, from fear, anger, deep grief, prolonged mental strain. Morris (Med. Rec., Jan. 22, 1921).

Emotional stress alone may be sufficient to bring on hyperthyroidism in a previously normal person. The writer obtained a history of intense emotional stress coinciding with the onset of this condition in 28 per cent. of 159 cases. From clinical observation there seems no doubt that in quite a number of hyperthyroid cases the cause is toxic absorption from the intestinal tract, which, in turn, may have been promoted by some deformity therein, either congenital, or acquired as a result of severe local infection and inflammation. Marañon (Ann. de méd., Feb., 1921).

Rheumatism and arthritis have been deemed etiological factors of goiter; but these diseases being themselves traceable to focal infections, particularly of the tonsils and teeth, it is probable that in many instances it is merely a matter of concomitance of the goiter and of the general disorders observed as results of the focal infections.

The writer observed an important relationship between *rheumatism* and goiter. The periods of increased incidence of rheumatism and goiter synchronize markedly with puberty, the child-bearing decades, and the menopause—*viz.*, with those physiological processes (menstruation, pregnancy, lactation) which determine oft-recurring or enduring hyperemia of the thyroid. The increased incidence of *osteoarthritis* in females at the menopause is doubtless dependent on the senile atrophy of the thyroid incidental to this epoch. Clinically speaking, the association between "rheumatism" and thyroid deficiency is intimate. The "rheumatic" child often shows minor signs of hypothyroidism. Again, rheumatic fever is often followed by a state of hypothyroidism. He has

noted the following peculiarities suggestive of a link with goiter: (1) In regions where goiter is endemic, the incidence not only of rheumatic fever and cardiac rheumatism, but also of rheumatoid arthritis, appears to be abnormally high. (2) If rheumatic fever develops in the child of a goitrous mother, it shows a strong impetus to chronicity, being rebellious to salicylates. Also, if it occurs in the child of a mother not necessarily goitrous, but resident in a region where goiter is endemic, it may show the same peculiarities. (3) This obduracy to salicylates relents if thyroid be superadded, the thyroid seeming to activate the otherwise impotent salicylates. As to rheumatoid arthritis and osteoarthritis, their association with hypothyroidism and often with goiter is well established. The favorable response of these disturbances to thyroid therapy is likewise generally realized. Llewellyn (Lancet, March 7, 1925).

**PATHOLOGY.**—Although the plea that surgery is indicated in toxic adenoma is based on the view that it is an encapsulated growth, such is by no means always the case. A single adenoma may be present but multiple adenomata are frequent, and any of these may or may not be encapsulated. Again the presence of a capsule implies a limited circulation; in truth, as we have seen, many vessels reach the growths, thus indicating that, like all other neoplasms, they are dependent for their development upon the volume of blood admitted to them, even though their vascular channels be histologically abnormal. This, as we shall see, affords opportunity for medication on lines similar to those used in exophthalmic goiter, provided rational treatment is used, and not what surgeons deem to be such and which insures failure except where self-limitation is the actual cause of recovery.

Exophthalmic goiter and toxic adenomata are two closely related diseases of the thyroid gland which, through their pathologic effects, produce systemic reactions and become systemic in nature. There may be a combination of the two conditions in the same gland, just as either condition may be superimposed on the colloid goiter. W. L. Bowen (Ill. Med. Jour., Nov., 1925).

Whether we look upon adenomata as arising from colloid goiters or from embryological rests does not militate against the fact that hyperfunction prevails whether it be the adenomatous tissue itself which, as some believe, elaborates the excessive thyroid secretions, or whether as others argue, on feeble grounds, that the adenoma excites neighboring secretory tissues to excessive activity. The predominant fact is that in either case we have overacting secretory thyroid tissues the functional activity of which is controlled by the arterial supply to these tissues which, in the present connection, is excessive.

**TREATMENT.**—In the light of the foregoing data, surgery is no more indicated in many cases of toxic adenoma than it is in exophthalmic goiter, and my results in such cases have shown that provided the treatment be based on a clear conception of the pathogenesis of each case, and provided the organ has not been functionally destroyed by degenerated or sclerotic tissues or an accumulation of such sufficient to render the organ dangerous mechanically through pressure, the chances of recovery are quite as promising as they are in Graves's disease.

An essential feature in this connection is that the patient strictly follow out all therapeutic and dietetic instructions. It is in this direction

that the clinician encounters difficulties. Lured by the rapid recoveries, temporary in many cases, and disregarding after-effects which can only with the greatest difficulty be counteracted, the patient consents to the partial elimination of his thyroid. It has been my unfortunate lot to see several such cases in which the administration of thyroid gland failed totally to compensate for the loss of thyroid tissue suffered during the thyroidectomy. Such patients do not show frank myxedematous symptoms, but a syndrome in which all functions, physical and mental, are impaired through evident deficiency of their pabulum vitæ.

The underlying cause of these morbid phenomena is perhaps made clear by the fact, which I have urged elsewhere, that the thyroid mechanism may roughly be compared to the spark plug of a motor car, which by freeing suddenly the energy stored in the gasoline endows the whole mechanism with its active power. The thyroid hormone, by increasing the lability of the phospholipoid lecithin in the nervous tissues, —kephalin in the brain, cuorin in the heart—(all lecithins approximately, I might say),—enhances vigorously their sensitiveness to oxidation in all tissues. The thyroid mechanism is needed to convert iodine administered in any form into the physiologic product.

The treatment, therefore, should be inspired by the desire to preserve the gland and to restore it to its normal functional activity, even though retrograde tissues, sclerotic areas, etc., remain. It should not be forgotten that many children are subjected to such conditions through life as a result of diseases peculiar to

childhood and that they only influence development, mental and physical to any material degree when extensive, so great is the margin of thyroid tissue available in the gland.

The first object is to discover and **eliminate any source of toxemia**. As we have seen, chronic tonsillar abscesses, often hidden, purulent sinusitis and dental abscess are dominant causes of the trouble. Examination of the teeth requires the X-rays and of the tonsils a trained laryngologist. The cecal tonsil or agminated gland may be a source of trouble, particularly with autointoxication of gastrointestinal origin. As I have urged, mental stress, fear, accidents, also produce a toxemia, which, as in the other forms, the thyroid apparatus attempts to overcome by assuming abnormal functional activity, the cause of its enlargement which is termed "goiter."

On the basis of 1015 cases of hyperthyroidism, the writer urges that it is essentially a medical affection. The only 2 indications for surgical treatment are symptoms of compression and the failure of careful, persevering medical treatment. General **hygiene, diet, and physical and mental rest** are essential. The history should be studied to discover and eliminate possible factors causing or aggravating thyroid hyperfunction, which may be of a psychic or of an infectious type. Marañon (Rev. de méd., xli, 248, 1924).

As regards **diet**, the essential feature is to **avoid heavy meats, i.e., beef, veal and pork**. It should be remembered, in this connection, that hyperthyroidism means excessive metabolism and, therefore, a rapid utilization of proteins and fats, including the body lecithins. The excellent appetite which these cases show is, therefore, compensative. If

digested without trouble the food intake should not be restricted, therefore. An essential feature, however, in order to avoid gastrointestinal disorders to which these cases are liable, is to avoid the administration of food, cream or milk, etc., between meals. Otherwise both these and foods taken at the regular meals are inadequately digested, and besides gastrointestinal symptoms, indigestion, diarrhea, etc., intermediate waste-products of hydrolysis are absorbed and aggravate the general disorder by provoking overactivity of the thyroid.

**Rest** is as essential in this disorder as it is in exophthalmic goiter. Here the exertion involved in the usual physical occupations also provokes the formation of wastes which likewise augment thyroid activity and, as a result, keep up the congestion and abnormal size of the gland. The bed and the lounge should be adhered to as long as the tachycardia lasts after elimination or correction of the causal disorders. In cases due to psychic stress from emotion, accidents, etc., rest is also of paramount importance.

Insofar as remedies are concerned **iodine and the use of iodized table salt should be strictly avoided**. The iodine craze, in which this halogen is being prescribed by physicians without regard to the kind of goiter present and used by patients on the recommendation of commercial circulars, is doing great harm, particularly when it happens to coincide with toxic adenomas.

Only a few have dared venture their opinions against the indiscriminate use of iodine in every kind of goiter and thyroid condition. Bram is absolutely opposed to iodine medication as a routine. As Sajous remarks, even patients with chronic goiter of endemic



type often do not bear iodine and it acts as a general toxic. The writer in a series of 200 unselected cases found that whenever iodine had been administered for any length of time there was invariably more or less exaggeration of the heart rate. As Plummer has shown, if a goiter contains adenomatous tissue the administration of iodine is not safe. M. Kern (Ill. Med. Jour., Nov., 1925).

The next indication in point is to reduce the amount of arterial blood admitted to the thyroid apparatus and thus to inhibit its secretory activity. Forchheimer, at a time when pathologists had not introduced the present distinction between toxic adenomas and exophthalmic goiter, and all toxic goiters were classed among the latter, obtained excellent results by means of **ergotin**, introduced by Trousseau, and **quinine hydrobromide** which he, Forchheimer, combined with it, administering 5 grains (0.30 Gm.) of the latter and 1 grain (0.065 Gm.) of ergotin in gelatin-coated pills four times daily.

"The ergotin," he wrote (1913), "was prescribed because of its effects upon the blood-vessels causing contraction. In this way many symptoms due to dilatation of the blood-vessels were controlled." As to the quinine, he referred to Huchard as claiming that it acted as "a cardiac tonic," possessing "vasoconstrictor properties."

Just as Shattuck, Jackson, Mead and many others have praised these agents, so have I found them very effective in both exophthalmic goiter and toxic adenomatous goiters. Some cases require larger doses of ergotin, and I have given up to 6 grains (0.4 Gm.) daily, but muscular cramps may attend the use of this quantity. Cessation of its use a few days, how-

ever, can be followed by resumption in increasing doses. The bromine ion seems to mitigate materially the tendency of the quinine salt to cause tinnitus; but if the latter does occur, it usually ceases after a few days.

An important feature in the treatment of these cases is the replacement of the cellular constituents which the high metabolic rate consumes inordinately. It has long been observed that **thymus gland**, **ovarian gland**, **corpus luteum** and **interrenal gland** were of value in this connection.

The writer tried in 4 cases a 50 per cent. glycerol emulsion of fresh ox **interrenal glands** from which practically all the epinephrin tissue had been removed. The average dose was 30 c.c. daily. There was a rapid gain in body weight and improvement in muscle strength, associated in the asthenic patients with hypotension with a progressive rise in blood-pressure to about the normal level, where it remained. There occurred also a temporary rise in heat production, which persisted as long as 3 months after medication was stopped without any fall in weight. Another effect, a source of great relief to the patient, was the influence on abnormal menstruation. Diarrhea usually disappeared with the general improvement. Shapiro (Endocrinol., Sept., 1924).

These various agents proving very unreliable in my hands, I found that this was due to the fact that some of these various products were prepared from defatted glands and it was the extracted lipoids in the fats which contained the active principle, *i.e.*, the phospholipoid **lecithin**. I now use the latter preparation in from 1 to 3 grain (0.065 to 0.2 Gm.), doses before meals. It is taken up with the food and is so effective that emaciation is not only counteracted but the

patient increases in weight. It is important, however, to employ a pure preparation, for the admixture of cholesterol which occurs with it in nature inhibits its activity. **Glyceroles of lecithin** are also available on the market. In teaspoonful doses before each meal these preparations are also efficient.

Of major importance in this connection is the influence of lecithin on the heart. While **digitalis** is a heart stimulant it should not be overlooked in the present connection that the organ is already over-stimulated owing to the prevailing hypermetabolism, and that its own organic phosphorus is correspondingly over-consumed. Hence the fact that fibrillation is sometimes brought on by digitalis.

On this account I have introduced the use of **lecithin** for a couple of weeks before digitalis—if used at all—not only to restock the heart with its organic phosphorus (cuorin), but also the neural mechanism, which, when deficient in phospholipoids, tend to promote, in true hyperthyroidism, irregularity and tachycardia.

**Glycerophosphates** may be used with advantage in these cases when lecithin cannot be obtained.

The danger of fibrillation which attends the use of digitalis applies also to that of **quinidine sulphate**, and marked untoward effects have been reported from the use of this drug, even though it is of value. The preliminary use of **lecithin**, however, tends to obviate these dangers.

The writer found **quinidine sulphate** of signal advantage in a severe case of tachyarrhythmia due to toxic goiter, digitalis having proved useless. The dose given on the first day was 0.6 Gm. (10 grains). Improvement in-

stantly followed; by the 2d day the pulse had fallen to 80 and was more regular. The same dosage was continued. When it was reduced to 0.4 Gm. (6 grains), the pulse-rate began again to rise. After 8 days the supply of quinidine ran out, and for the next 3 days there were 2 attacks of tachycardia. Resumption of the drug promptly restored the former rhythm. After 25 days it was necessary to give quinidine only every 2d or 3d day. The patient was able to return to her occupation, and what was still more remarkable than her cardiovascular recovery was the almost complete disappearance of the goiter; it was even smaller than it had been before the menopause. Benhamon (Paris méd., Mar. 10, 1923).

Most of the cardiac affections produced by thyroid disease are associated with those toxic states in which there is an elevation of the basal metabolism. So far as the disturbances of the cardiovascular system are concerned, there is little difference between typical exophthalmic goiter and so-called "adenoma with hyperthyroidism." In discussing the cardiac aspects of these conditions, the writer distinguishes between primary disturbances of the heart and secondary disturbances of the heart. Under the former heading, he includes those cardiac symptoms and signs which occur invariably, or almost invariably, in severe cases of *thyrotoxicosis*, and which may be considered, therefore, cardinal manifestations of thyroid intoxication. Under the second heading, on the other hand, he includes those cardiac abnormalities which, because of their relative infrequency, or because their frequency and intensity do not vary directly with the intensity of the other symptoms of the primary disease, may properly be looked on as complications. Of the primary disturbances of the heart, sinus tachycardia and the evidences of over-activity of the heart associated with it are the most common. Of the cardiac complications of thyrotoxicosis, enlargement of the heart is one of the

most important. Clinical evidence of myocardial changes in toxic goiter is by no means rare. Death resulting purely from the cardiac complications of toxic goiter is relatively uncommon. It is true that, in so-called postoperative thyroid shock, auricular fibrillation, with extreme ventricular tachycardia and indications of cardiovascular collapse, are seen; but necropsies in such cases usually show severe degenerative changes in the liver and other parenchymatous organs, indicating death from profound toxemia. It is probable that death results in such instances from overwhelming intoxication, in which the heart suffers along with the other vital organs. Milder grades of cardiac weakness are not infrequent, and should be treated exactly as under other circumstances, by **rest**; **morphine** when necessary to relieve dyspnea or insure complete rest and sleep; **digitalis** in amounts sufficient to produce its characteristic effects, and a proper diet. The diet should be designed to meet the caloric requirements, or, perhaps, for the first few days, to fall somewhat below them; it should contain only sufficient protein to prevent a negative nitrogen balance, and should be poor in salt. As to whether adenomatous goiter without hyperthyroidism may damage the heart, it is difficult to form an opinion. Nevertheless, it is clear that a persistent enlargement of the thyroid gland, even though it be regarded as non-toxic is a potential menace to the myocardium. Wilson (Jour. Amer. Med. Assoc., May 31, 1924).

Auxiliary measures are of considerable aid. Insomnia should be counteracted by **barbital** or, if the patient be excitable, by **sodium bromide** with **chloral**, both of which agents in no way counteract the effects of the curative remedies used unless large doses be given. The **ice-bag** applied over the thyroid area is also of service to mitigate any local discomfort.

### Accessory Methods of Treatment.

—It has been held by various authors that toxic goiters are self-limited and that even in exophthalmic goiter, 60 to 70 per cent. of the cases recover spontaneously. If such is actually the case, we have an additional argument against the reckless surgical removal of the thyroid gland now practiced, in this country in particular, regardless of the intimate relations between this gland and parturition, the effects on the offspring, and especially congenital goiter,—all questions referred to later in the present article.

In regard to the statement that the various forms of toxic goiter are self-limited, I cannot refer to any personal experience, since I never allow my patients to run the gauntlet of the many possible complications entailed. Goiter countries such as our Middle West and Switzerland suggest that goiter persists, in most cases other than adolescent goiters, to the end of life. But here the cause itself is continuous—just as much in the Middle West as it is in Switzerland. The protective administration of iodine is a useful measure in most instances, but all it does is to increase the ability of the child in schools and elsewhere to better combat the pathogenic factor or organic toxic, whether this be bacterial or in the nature of excrementitious products, as is the case in Switzerland and, in all probability, in the Great Lake regions.

On the whole, search and elimination of all or any of the factors previously enumerated, tonsillar, gingival, dental, etc., which keep up the defensive reaction of the thyroid and the toxicosis, is the first measure indicated. Once determined and ap-

propriate measures instituted, we should remember that *a toxic thyroid of any kind requires an adequate blood supply to enable it to elaborate its toxic product*. Hence the undoubted value of vasoconstrictors, **ergot**, **quinine hydrobromide** and others.

These resources, reviewed in the foregoing pages, alone lead to a permanent cure in cases in which organized products of degeneration, sclerotic, calcareous or disconnected from the circulation, do not prevent it. Such cases are not toxic as a rule; but if they are, it is because, besides these lifeless products of degeneration, they contain hyperplastic tissue. Such cases should likewise be treated on the lines described, and when the toxic phenomena have disappeared and the basal metabolism has been reduced to normal by the treatment, the careful **surgical dissection of the functionless tissues** should be resorted to, not only for cosmetic purposes, but also to arrest the irritation which provokes over-activity of the functional tissues in the gland and of the parathyroid glandules.

In addition to the fundamental measures recited are various accessory measures of great value, and others which promise to become such.

Prominent among these is radiation by **X-rays**. Here again, however, precautions are necessary to avoid harm, direct and indirect. These rays are indicated mainly in thyrotoxicosis in any of its forms, in the toxic adenomata as well as in Graves's disease or hyperthyroidism, to assist the measures previously recommended and hasten recovery. Cure is sometimes obtained with no other measure where the causal toxemia has spent

itself, as is often the case when the teeth are, or an intestinal factor is, the source of the autointoxication. It is among such patients that the so-called "self-limited" cases are found.

The secreting power of the gland is mainly influenced by the X-rays. Again, in highly toxic goiters especially, a dangerous exacerbation may be produced unless relatively small dosage, repeated at 3 weeks' intervals, be alone used. Ultra-penetrating radiations with high voltage should be avoided, and it is imperative to avoid any cutaneous reaction. High dosage has been known to cause myxedema, with its evil consequences on the offspring.

The **X-rays**, besides reducing thyroid cellular activity, induce an obliterating endarteritis. While 4 to 8 full dosage treatments, usually every 21 days, are required to cure, full dosage cannot be given at once in highly toxic cases. Sometimes full effects were not obtained until the *thymus* was irradiated in addition. Trostler (Ill. Med. Jour., Jan., 1923).

High dosage of **X-rays** on the thyroid of rabbits will cause sterility besides general morbid phenomena. Comparative studies of rabbits so treated showed that dwarfism, with deficiency of colloid in the thyroid, and abnormally small adrenals resulted. Coulaud (C. r. Soc. de biol.; Paris méd., Jan. 27, 1923).

Occasional failures are due to neglect of the rule that **rest and freedom from worry and excitement** (in addition to medicinal treatment) should always form concomitants of X-ray therapy; highly toxic patients should have complete rest in bed. All patients whose symptoms persisted after previous surgical treatment improved under X-ray treatment. J. G. Williams (Long Isl. Med. Jour., Sept., 1923).

The **X-rays** lower the basal metabolic rate in thyrotoxis. A period of

from 3 to 6 months is necessary to obtain marked improvement or return to normal. The higher the initial metabolic rate, the longer must the treatment be. None of the author's 55 patients was injured by the irradiation. Read (Cal. State Jour. Med., Jan., 1924).

The **X-rays** should be **avoided** when the goiter causes pressure symptoms in a non-toxic patient who gives a low basal metabolic index. Here **surgery** is required. Conversely, the rays are indicated particularly in the non-hypertrophic toxic goiters which give a high metabolic index. Such cases are poor surgical risks. Skinner and Lockwood (Jour. Mo. State Med. Assoc., Jan., 1926).

The use of **radium** has been commended in both toxic adenoma and Graves's disease cases. It causes reduction of the basal metabolic rate, and abatement of all morbid phenomena in from 3 to 9 months.

The writer has used **radium** in nearly all types of goiter experimentally for 4 years. A change was noticed in 45 per cent. of cases, 35 per cent. being cured, and the rest not benefited. The treatment is indicated where there is excessive thyroid secretion. Hagans (Internat. Jour. of Med. and Surg., Apr., 1924).

Adducing an analysis of 25 cases, the writer states that the only cases truly benefited were those of exophthalmic goiter, which showed improvement after the first application. The **radium** was applied to the neck over the thyroid, screened first by a brass container and then by a wooden block about 6 cm. in depth. A total exposure of 250 millicurie-hours is obtained by applying 100 mg. of radium for 2½ hours. J. C. Scal (Med. Jour. and Rec., Dec. 16, 1925).

A newer method of using **radium** was introduced in 1923 (Am. Jour. of Roentg., Nov., 1923). by J. O. Bower and J. H. Clark. It was employed in three types of thyroid en-

largement: a recurrent carcinoma, simple goiter and toxic goiter. Radium needles were buried under local anesthesia. Although large doses were employed, no untoward symptoms were noticed.

The authors found **buried radium** needles far superior to the injection of **boiling water, quinine and urea, or polar ligation**. (See GRAVES'S DISEASE, this Volume.) The method is indicated in cases that are poor operative risks. Owing to the apparent resistance of thyroid tissue to radium rays, as found from experimental work, comparatively large doses of buried element should be employed.

The primary changes induced by buried radium in the thyroid were hemorrhage and necrosis. Organization and healing were evident in the 3d week and complete about the 12th. No changes were demonstrable in the parathyroids. The apparent resistance of the thyroid tissue to radiation suggests that implantation is superior to surface applications. Bower and Clark (Am. Jour. of Roentg., Aug., 1923).

Another promising method is that introduced by J. H. Frick in 1926, before the American Association for the Study of Goiter (Medical World, Apr., 1926). It consists in administering **sodium iodide, 2.15 Gm. (24 grains)** in 15 c.c. (½ ounce) of sterile water intravenously at weekly intervals. All the untoward symptoms observed after the oral administration of iodine or of the iodides were thus avoided, even after a series of 16 injections. In 14 cases in which the method was used no sign of iodism or typical iodide rash occurred. The method is designed particularly as a preliminary to quickly prepare the patient for operative pro-

cedures and for the prevention of post-operative complications.

**NODULAR OR LOBULATED GOITERS.**—While these goiters are, on the whole, benign aside from the mechanical difficulties they may initiate, they may sooner or later develop into toxic goiters. They consist mainly of large acini filled with colloid, but often show a marked in-

without some degeneration; epithelium somewhat flattened; possibly a marked increase in the interstitial cells; hemorrhage and pseudo-cyst formation. Hertzler (*Am. Jour. of Surg.*, Sept., 1925).

On the whole, nodular goiters develop in one or several parts of the gland and differ in this respect from the diffuse non-toxic goiter, which involves all parts of the organ. The



Radium needles embedded in left lobe of the thyroid. (BOWER and CLARK, in *Amer. Jour. of Roentgenol.*)

crease of interstitial cells, areas of hemorrhage, and occasionally pseudocyst formation. The great majority of nodular tumors represent a combination of the various forms of goiter, and are designated according to the predominant alteration.

The characteristics of lobulated goiter are: Adult life only. Constitutional symptoms: Little difficulty except from the size of goiter ("innocent goiters"); possibly toxic symptoms sooner or later. The gland: Irregular bilateral enlargement. Histology: Large acini filled with colloid, with or

affected areas may be the seat either of an increase of follicles, vessels, etc., a true hypertrophy, or of accumulations of more or less thick and tenacious colloid, which dilates one or more follicles. These areas, especially when a single nodule is present, tend to degenerate, owing to the influence of the proliferated tissues upon the neighboring structures and upon the local vascular supply, and to become the seat of hemorrhages.

Nodule of the isthmus is relatively frequent, the mass projecting from

the middle of the neck. Nodular goiters tend to grow rapidly, and seldom yield to internal measures.

As goitrous masses may develop anywhere in the gland, and simultaneously in several parts of the organ, while varying greatly in shape and size, the pressure effects they produce vary greatly with each case. The trachea may be displaced from side to side, twisted, or compressed against the spine, thus producing dyspnea; the cervical vessels and the vagus may also be pressed upon, causing congestive disorders of the brain, syncope, slowing of the pulse and dyspnea. Hoarseness and aphonia may occur, if the recurrent laryngeal is pressed upon. Occasionally, sympathetic nerves are compressed, thus giving rise to vascular phenomena or paralysis in the parts which these nerves supply.

Development of a nodule from either inferior horn, the growth growing downward, gives rise to a form of goiter known as **intrathoracic goiter**. At first remaining above the suprasternal notch, it finally passes down into the thorax, behind the sternum, being aided in doing so by the downward movement of the thyroid and the suction of the enlarged organ into the chest, which occur during inspiration. It is apt to be met in subjects who, owing to their occupation, are obliged to bend the head forward, as in writing, during prolonged periods each day, and in short-necked individuals. As the intrathoracic goiter develops, tending to become very large, the resistance of the sternum causes it to compress markedly the structures on either side of the trachea and the latter itself, and it may lead to sudden death.

The X-rays aid in establishing the diagnosis when symptoms of compression are present. (See below.)

A nodular mass may grow in such a way as to pass behind the trachea and encircle and constrict it, constituting a dangerous variety known as **constrictive goiter**. It may also be due to embryonal malformation of the organ, both of its superior horns encircling the trachea or esophagus.

Nodular goiters are in most instances accompanied by symptoms of hypothyroidism, but are seldom reduced to any material degree by iodine or thyroid gland, owing to the overgrowth of interstitial fibrous tissue, cysts, etc., of which they become the seat. The organ being gradually destroyed as a functional entity through these degenerative changes, there may develop cretinism, if the goiter begins in early childhood, and myxedema, if the growth occurs in the adult. In most instances, however, enough of normal tissue remains in the organ to carry on its functions, this being aided by the formation of new secretory follicles.

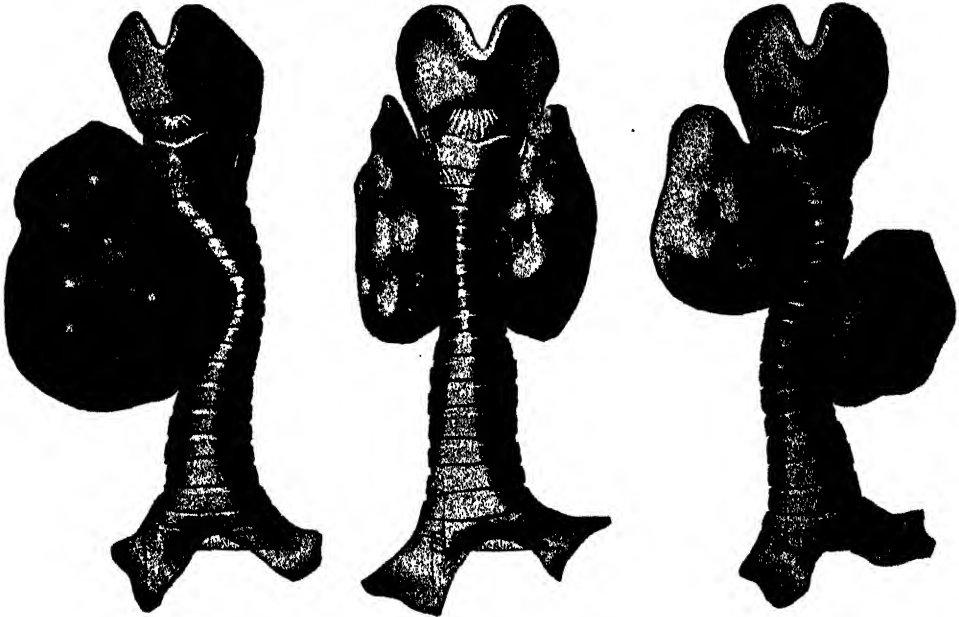
**Obstructive and Pressure Symptoms.**—Certain symptoms occur only when any goiter has become sufficiently large to interfere with the functions of neighboring structures and their circulation and nervous supply.

*Dyspnea* is a prominent symptom of goiters that have reached sufficient size to compress either the trachea, and thus interfere directly with respiration, or the blood-vessels of the neck and neighboring structures, thus disturbing the circulation and the equable return of blood to the heart and lungs; or, a goiter may compress the recurrent laryngeal nerve.

The dyspnea is increased by tem-

porary hyperemia of the goiter, by conditions which increase the demand for air, such as exertion, and by local catarrhal inflammation due to the pressure. When the trachea is markedly compressed, *tracheal stridor*, a loud, whistling sound, may be heard during both inspiration and expiration. Paralysis of the vocal cords is frequent.

Cardiac phenomena are frequent in goiter. The dyspnea is often increased by *dilatation of the heart*, due to the interference with the respiration referred to above. The heart should always be examined in these cases, since appropriate treatment is very helpful. Dilatation of the heart may also be due to pressure exerted by the goiter on the blood-vessels,



Distortion of trachea produced by nodular goiters, the isthmus being removed. Partly schematic. (Kocher.)

*Asphyxia* may readily be produced in such cases by sudden violent exertion, bending the head in such a way as to increase pressure of the growth on the trachea; sudden pressure on the growth, constriction of the neck, violent cough; hemorrhage into the goiter, thus suddenly increasing its dimensions; swallowing the wrong way, anger, by causing turgescence of the cervical vessels, etc. Cyanosis is not a necessary symptom of threatening asphyxia, being often caused by pressure on the veins.

and to the effects of the toxemia upon its muscular elements. Finally, when the goitrous morbid process is sufficiently advanced, the characteristic *tachycardia* of exophthalmic goiter with its other symptoms may also appear.

*Cyanosis* is apt to occur when the veins which drain the head, neck, and arms are compressed by the growth. It is apt to be especially marked during exertion. It affects chiefly the cheeks, lips, and tongue, and also the arms when the innominate veins are



compressed. *Edema* of all these structures also occurs when the pressure attains a marked degree. The affected arm is sometimes raised with difficulty. *Headache, vertigo*, and other signs of congestion occur when the cervical arteries are compressed.

*Pain* occurs in a goiter only when it is the seat of inflammation (see STRUMITIS) or hemorrhage; in the latter case, however, it soon ceases. Malignant tumors are also the seat of radiating pain in most cases.

*Hoarseness* is frequently observed in goiters that are sufficiently large to cause distortion of the trachea or pressure upon the cricoid and thyroid cartilages, thus interfering with the proper anatomical relations. Hoarseness may also be caused by pressure upon the recurrent laryngeal nerve, and by a chronic catarrhal process of the laryngotracheal mucous membrane, due in turn to the pressure and the interference with the functions of the epithelium through which the membrane is kept free of foreign substances, mucus, etc.

*Paralysis* of muscles of the arm, and *numbness* of the fingers, occasionally met with, are due to pressure upon the brachial plexus. These symptoms are mainly observed in intrathoracic goiter. *Irritability, nervousness, restlessness*, and other nervous phenomena may also be witnessed when hyperthyroidism is a feature of the case, which it is not in true goiter. *Insanity* is more frequent, however, in goitrous than in normal individuals.

**Treatment.**—Pressure symptoms can only be aggravated by medication. Any preparation of iodine or the iodides is dangerous in such cases as it tends to promote infiltration of the submucous tissues. Surgical in-

tervention is always indicated, as fatal asphyxia may be induced at any moment by some intercurrent disorder which entails enlargement of the goiter.

### FIBROUS OR LIGNEOUS GOITER.

**RIEDEL'S DISEASE.**—Fibrous goiter differs entirely from the foregoing pathologically in that it is due to the development of fibrous tissue, a result of local inflammation in various parts of the organ. It is, therefore, hard under pressure and nodular. The glandular elements being more or less compressed by the fibrous tissue, their functional power is inhibited, causing a corresponding degree of hypothyroidism, which, when advanced, may reach the stage of true myxedema. In some cases the goiter becomes as hard as wood; hence the terms *ligneous goiter* and *Riedel's disease* sometimes attributed to it.

In 1896 Riedel described 2 cases of "iron hard strumitis." He and others have since reported 17 instances. More than half of these were in men in their fourth decade. The growth is extremely hard and firmly fixed, its surface being smooth and detached from the skin. The adjoining glands show no particular enlargement. The tissues of the growth are white and homogeneous and composed of dense fibrous tissue of an inflammatory type. Delore and Alamartine (*Revue de chir.*, July, 1911).

A distinctive feature is the rapid evolution of the disease. In a few months, or even weeks, a tumor develops, which produces serious effects by compression of the trachea and the recurrent laryngeal nerves; the laryngeal palsy is accompanied by dangerous paroxysms of dyspnea.

On the other hand, it is unusual to find any evidence of pressure on the sympathetic nerves or upon the esophagus. The tumor is diffuse, involving the whole gland.

Myxedema developed subsequent to removal of the gland in a case of Riedel's disease, which, however, could be controlled by thyroid substance. Microscopic examination of the tissues showed complete sclerosis. This differs from the histology of myxedema in that it penetrates the capsule. Murray and Southam (Lancet, May 4, 1912).

In a case of Riedel's disease reported by the writer, iodine proved useless. Peculiar cell nests were found which were evidently post-branchial remnants, even though no main duct representing the original pharyngeal pouch was found. Post-branchial remnants have been found in the thyroid of embryos, in athyrosis and in cretins, but not in normal adult thyroid glands. Louise H. Meeker (Am. Jour. of Pathol., Jan., 1925).

**ABERRANT GOITERS.**—Some goiters occur in unusual situations; behind the trachea or esophagus, at the base of the tongue, on the side of the neck, in the ovary, etc., which, though benign, may more or less readily become malignant. The following types, however, may show malignancy from the start:—

**Goitrous accessory glands**, especially those lying between the trachea and esophagus or behind the esophagus, may become the seat of malignant tumors and cause correspondingly grave pressure symptoms. Others, lying between the hyoid bone and the aortic arch, and which resemble lymph-glands, may also be the seat of goitrous development, occasionally malignant.

**Lingual goiter** is an interesting, though rare, form of goiter which is

more frequent in women than in men, though in the latter accessory thyroids are more common. When they become goitrous this occurs with relative suddenness, the growth showing great vascularity. Lingual thyroids are situated upon the dorsum of the tongue behind and below the foramen cecum, and are sometimes very large. They cause prolonged fits of coughing and deglutition and hoarseness.

In reporting an additional case to the 100 on record, the writer states that the removal of a lingual goiter may deprive the patient of all thyroid tissue. Postoperative myxedema and tetany have been observed in 9 and 22 per cent. of the cases (Asch and Lenzi). In Asch's case the myxedema and tetany gradually improved in time. Only 12 per cent. of the cases of lingual goiter have been observed in males. Rossteucher (Deut. Zeit. f. Chir., clxxxii, 217, 1923).

When a lingual goiter becomes malignant, the tendency of *sarcoma* is to grow more rapidly than *carcinoma*, which, however, is more painful. The tongue, fortunately, is more frequently the seat of benign growths such as *dermoid cysts*, *gunmata*, *calcareous deposits*, etc.

**Treatment.**—All such goiters, when so located that they interfere with some important function, respiration, deglutition, etc., require **surgical intervention**—partial or with **transplantation** elsewhere in the body, should the aberrant thyroid be the only one present.

**MALIGNANT GOITER.**—Such a goiter may develop as a primary *carcinoma* or as a *sarcoma* of the gland proper, but in most instances it appears as a complication of a parenchymatous goiter of long standing. The *diffuse malignant adenoma*, due to

changes in the follicles similar to those observed in adenoma elsewhere, is a rare form which, owing to its lobulated surface, resembles the diffuse colloid. But its tendency to recur after removal shows its malignant nature.

The occurrence of pain in a pre-existing goiter, if it cannot be traced to a strumitis, is suggestive of malignant changes, especially if the cachectic facies is present. The surrounding lymph-glands are involved relatively early. While metastases seem to show a predilection for the osseous system in carcinoma of the thyroid, sarcoma tends to spread to the neighboring tissues of the neck, trachea, etc.

The authors analyzed 103 cases of malignant goiter treated in the von Eiselsberg Clinic from 1901 to 1922. Of the total, 62 were in women. None of the males were below 30 years of age and but 2 in their fourth decade. The females gave but 4 cases in the third decade; the incidence in them increased with the age, with a marked rise at and after menopause. The average duration of the cancer in them was 5 months; in the males, 4 months. In general the goiter had been present more than 20 years in the men and over 23 years in the women before the onset of malignancy. Breitner and Just (*Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, xxxviii, 262, 1924).

The leading clinical signs of malignant goiter are: rapid growth of the goitrous mass with pain, dyspnea and concomitant hoarseness, difficult and painful deglutition, and emaciation. The onset is usually sudden, but while dyspnea is almost always the most prominent symptom, no reduction of the tracheal caliber can be detected in the X-ray examination. Benign goiters, however, may also give rise to radiating pain and dys-

phagia and emaciation; likewise, as we have seen, in toxic adenomas as well as in Graves's disease.

The diagnosis of malignant disease of the thyroid gland is difficult because of its rarity and because most malignant thyroid tumors for a long time produce no symptoms beyond the growing lump. Such a lump, small and hard, noticed in the thyroid of a middle-aged or elderly person, should always raise the suspicion of malignancy, even if no other sign or symptom is present. Yet, the great majority of small hard tumors in the thyroid are not malignant; they are usually old fibrous tumors or masses or cysts that have become calcified. It is important to distinguish between carcinoma of the cervical esophagus and malignant disease of the thyroid, especially because obstruction is usually a very late symptom in carcinoma of the cervical esophagus. If there is the least doubt, operation should not be undertaken unless X-ray and esophagoscopic examinations have been made. The essential diagnostic difficulties are met in the early stages when there is still some hope of bringing about a cure by surgical interference. No one sign is certain evidence of carcinoma. The short history, the steady growth and the hardness of the tumor, especially a nodular hardness which distinguishes this condition from a calcified adenoma, and a certain amount of fixation to the trachea, will make a positive diagnosis almost certain. Berry, Williamson and Trotter (*Proc. Royal Soc. of Med.*, xviii, 25, *Surg. Sect.*, 1925).

Metastases are infrequently observed in patients other than those in their fourth decade or beyond, and in goiters of very long standing, some since childhood. Fixity of the tumor, though a tardy sign, after the goiter has been freely movable, is suggestive of cancer.

Cancer occasionally develops in aberrant thyroids. A rare type of

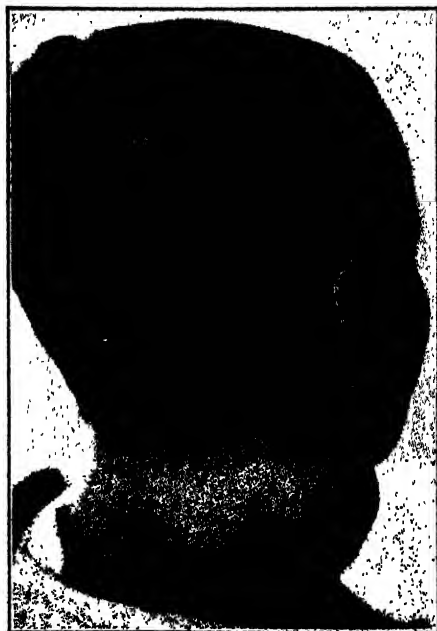
this complication is shown in the annexed illustration, that of a case reported by Greensfelder and Bettman (*Jour. Am. Med. Assoc.*, Mar. 18, 1922).

**Treatment.**—The importance of **early surgical measures** is illustrated by the observation of Balfour at the Mayo Clinic (*Amer. Jour. Med. Sci.*, July, 1925) in 103 cases, that 70 per cent. of successful operations occurred in patients in whom malignancy was found unexpectedly. Where the disease is sufficiently advanced to make the diagnosis possible, surgery affords discouraging results. **X-ray** and **radium** treatment in heavy dosage have been recommended, but, should they fail, the chances of recovery through surgery have been correspondingly compromised. They are both helpful in inoperable cases, therefore, and as an adjunct to surgical measures.

While cancer of the thyroid on the surface is not very frequent, yet a thorough microscopic examination of each specimen removed would show it to be more frequent than is ordinarily supposed. In adenomas, carcinomatous areas have been found in almost any part within the periphery of the gland, where degenerative changes are in progress. Thyroid cancer is seldom primary, but occurs rather in adenomas of long standing. De Courcy (*Ann. of Surg.*, Oct., 1924).

The writer operated in 33 cases of thyroid cancer. Of these 10 were living at the date of report; 7 were free from evidence of tumor  $2\frac{1}{4}$  years to 7 years 11 months later. The other 3 living patients show definite improvement. The living patients were 12 years younger, on the average, when their treatment was begun, than those who died; and already they have lived 3 times as long after coming to the hospital as did those who died. On the basis of this study it would

seem best to advise **early complete removal** of all nodular tumors of the thyroid. It will disclose many unsuspected carcinomas. If it is present, prompt and thorough post-operative irradiation with **X-ray** or the **radium pack** should be used. If a clinical diagnosis of cancer of the thyroid can be made, operation should be avoided, and thorough irradiation, either by heavy X-ray or external radium applications, or these combined with an



Posterolateral view of a carcinoma in an aberrant thyroid. (*Greensfelder and Bettman.*)

efficient form of **interstitial radium application**, should be carried on. Craver (*Ann. of Surg.*, Dec., 1925).

### CONGENITAL GOITER, OR GOITER IN THE NEWBORN.

Congenital goiter is relatively frequent in the newborn and is often fatal, owing to pressure on the trachea, nerves, and blood-vessels of the cervical area.

Congenital goiters are more common than has been ordinarily supposed. All grades of pathologic change are observed, from a simple parenchyma-

tous goiter with no symptoms to marked enlargement with complete tracheal compression and cystic conditions causing serious danger to both mother and child. Skinner (Jour. Amer. Med. Assoc., Apr. 12, 1924).

The recklessness with which goiters are being removed adds to the aggregate of women who beget goitrous and mental defectives. To this may in part be attributed, in my opinion, the rapid increase of such defectives in the United States.

A study of family histories for 4 generations showed the familial tendency to the disease to be most noticeable in the second and third generations. This applied also to the cases from St. Louis. A gradual increase in the number of affected persons from the first to the third generations in the cases from Chicago was noted. The recorded family histories from St. Louis showed that 20 per cent. of the children of goitrous mothers were affected. Similar data from Chicago showed that 46 per cent. of the children of affected parents were goitrous. Tonsillitis or seasonal sore throat accompanied goiter symptoms in 40.8 per cent. of the cases. B. Lloyd (Ann. of Clin. Med., Oct., 1924).

In a case reported by the writer, a mother of 2 healthy children had been subjected to *partial* thyroidectomy for goiter. After 10 months a goitrous infant was born in an asphyxiated condition and died. A similar operation in rabbits revealed that gestation did not occur in the thyroidectomized animals. Neurath (Wiener klin. Woch., Nov. 5, 1925).

The goiter develops in such a way in some cases as to encircle the trachea and sufficiently compress it as to prevent respiration, constituting what has been termed in France the "constrictive goiter." It may also include the esophagus in its grasp, insinuating itself behind it, though appearing slightly or not at all externally.

**SYMPTOMS.**—Death may occur almost immediately after a few efforts at respiration. Many are born prematurely, or are stillborn. Or, the infant shows signs of asthma, reaching in some instances to intense dyspnea with cyanosis, the child's cry being shrill or rasping. Death may occur suddenly immediately after the cord is ligated. When the goiter is due to simple congestion of the thyroid from compression or any other cause during parturition, or to screaming or writhing, it may disappear within twenty-four hours, never to recur in some cases; more frequently, however, it reappears intermittently. Dysphagia due to pressure upon the esophagus is not infrequent, the infant, in some instances, refusing to nurse. The clinical signs, with the exception, perhaps, of a slight swelling of the front of the neck, may not appear until several weeks or more after birth.

The goiter may sometimes be felt, but in most instances it is quite small, and only discernible when the head is thrown back to stretch the neck.

In some cases the goiter is purely congestive, owing, probably, as during parturition, to pressure upon the infant's neck, especially in face presentations and when forceps are used. It may also be due to persistence of the fetal circulation, but in most instances is of the parenchymatous type and is inherited.

**PROGNOSIS.**—When the goiter is due to congestion from pressure, which may be suspected after face presentation or forceps cases, the prognosis is good, particularly if measures calculated to sustain oxygenation are resorted to. In true congenital goiter prompt surgical

procedures will alone save life when the growth is of sufficient size to cause pressure symptoms.

**TREATMENT.**—The main aim is to restore respiration and sustain it. The various forms of **artificial respiration** (see DROWNING, TREATMENT OF) with **oxygen** inhalations are very helpful. If, notwithstanding efforts in this direction, dyspnea recurs and persists, **section of the isthmus** or **exothyropexy** should be performed. The relief is immediate. Tracheotomy should never be resorted to; it is often followed by bronchopneumonia, hemorrhage, or other complications. **Intubation** has been recommended by some authors.

In the congestive type **cold compresses** to the neck and **warm foot-baths** or **hot baths** tend greatly to reduce the swelling of the gland. In parenchymatous goiter which does not threaten life, **thyroid gland**, 2 grains (0.13 Gm.) twice daily, administered to the nursing mother, causes gradual disappearance of the goiter in both mother and child in some instances. **Sodium iodide**, 5 grains (0.3 Gm.) three times daily, may be given instead if thyroid cannot be taken. A weak **iodine ointment**, rubbed gently into the goiter daily, avoiding cutaneous irritation, is also helpful. The tincture of iodine should not be used.

Pregnant women with goiter should be treated in the same way to arrest the possible development of a goiter in their offspring, and to prevent complications, by means of **thyroid gland** or **iodine**.

**THYROIDITIS.**—In the preceding sections I emphasized the influence of general toxemias upon the thyroid gland, including their effect

on its functional hyperactivity. Additional evidence to this effect is afforded by the occurrence of thyroiditis in the course of infections.

A comprehensive histologic study showed that the thyroid is frequently the site of inflammatory processes. All types of inflammation may occur therein. Chronic interstitial lesions are the most frequent, associated with other processes—simple hypertrophy, parenchymatous hyperplasia, etc. J. T. Watkins (Ann. of Clin. Med., Feb., 1926).

Various poisons have also been known to cause acute thyroiditis, thus constituting a form which has been termed "toxic thyroiditis." Iodine and the iodides are especially active in this connection. It is more apt to occur when the iodides are administered after mercury has been used.

The pathological process awakened may be of two kinds: (1) Excessive functional reaction of the gland to antagonize the accumulation of toxins due to the infection or other poisons that have accumulated in the general circulation; (2) invasion of the gland by pathogenic bacteria of the general infection present, which occurs as a complication of the defensive hyperemia. It is probable, however, that acute thyroiditis may be due to bacterial invasion alone, since some cases may either develop early in the course of, or at the end of, the general disorder.

Suppuration occurs occasionally, particularly in acute thyroiditis due to typhoid fever, where it appears in about 60 per cent. of the cases of thyroiditis from this cause. In some instances, the abscess may be sufficiently large to provoke pressure upon the trachea and suffocative symp-

toms. The cases may terminate by resolution or, very rarely, by gangrene.

**SYMPTOMS.**—These vary with the cause. When acute thyroiditis is primary, there are usually the chill, general malaise, and headache, which, as a rule, initiate febrile disorders. The region of the gland then becomes painful, first on one side, then on both sides,—in most cases,—while in others the entire gland is involved from the start. The pain, which radiates to one or both ears, the teeth and jaws, and even the chest, shoulders, arms, and occiput, may be very severe and is usually lancinating. It is aggravated by pressure on the gland or by extension of the neck, a fact which causes the patient to bow his head in order to relax the anterior cervical muscles.

Swelling of the gland sometimes appears on the first day, but usually only on the second. The organ may become very large, attaining, sometimes, the size of a hen's egg. Pressure symptoms, dysphagia,—which may occur as the initial symptom, due to compression of the esophagus,—and dyspnea—sometimes due to pressure on the trachea when the entire gland is involved—are always present. Cough and hoarseness are also produced in some cases.

When acute thyroiditis occurs in the course of an infectious disease, there is, as a rule, a rise of temperature, and all the phenomena above described develop, the swollen gland being sometimes exquisitely sensitive to the touch and markedly congested. The symptoms due to the pressure of the inflamed gland are, as a rule, more severe and may include epistaxis and edema of the larynx.

In some instances, the gland is

not greatly swollen. To determine that it is the organ actually involved, swallowing will cause the painful area, the gland, to rise, provided, of course, the head is not bent backward, which would immobilize the organ. Cardiovascular disturbances, slight exophthalmos, tremors, emaciation, and other symptoms suggesting Graves's disease (*q.v.*, this Volume) are sometimes observed.

Uncomplicated acute thyroiditis usually lasts but a few days, the swelling subsiding gradually. Sometimes, however, the disorder may persist several weeks.

When suppuration develops the case is protracted until the pus is evacuated. The abscess is rarely single, usually consisting of numerous purulent foci, which tend to run together and to break through the adjacent soft tissues, including the skin. When left to itself the purulent infiltration may cause serious complications, such as perforating the trachea or esophagus, or penetrating by burrowing to the mediastinum, pleura, and lungs, causing septic pneumonia, or along the sheaths of the great vessels of the neck, etc. Fluctuation may be difficult to obtain, owing to the smallness and dispersion of the purulent foci. Even an exploratory puncture may prove misleading in this respect.

The writer observed 2 cases of suppuration of the thyroid following pneumonia. Operation in both instances led to recovery. Bedrna (*Casop. lek. cesk.*, Nov. 15, 1924).

The sequelæ of these cases are sometimes serious, owing to the destructive lesions produced in the organ during the active stage of the morbid process. Fibrosis may ensue,

and cretinism or myxedema may appear. Such a case may even have begun with symptoms of exophthalmic goiter.

**DIAGNOSIS.**—The symptoms just enumerated usually render a diagnosis easy in well-marked cases. The conditions with which it may be confused, particularly at the start, are: when unilateral, with mastoiditis and parotitis; esophageal abscess, from which it may be differentiated by mobility of the gland during deglutition; the acute hyperemia of the thyroid previously described, sometimes attended with pain and fever; adenitis or cellulitis of parts adjoining the thyroid; hemorrhagic goiter due to rupture of some thyroidal vessel; cancer or tuberculosis of the thyroid, already described. All these disorders have characteristics which careful study of the case will soon reveal if any disorder other than thyroiditis be present.

**PROGNOSIS.**—Although the prognosis is influenced by the nature of the causative disorder and the development of complications, acute thyroiditis itself, without abscess, rarely proves fatal. The suppurative cases, however, show a greater mortality, owing to the complications—laryngeal edema, hemorrhage, sepsis, septic pneumonia, etc.—that may be awakened. Where it occurs as a complication of a general infection, it increases, of course, in proportion with its severity, the danger of a lethal ending.

**TREATMENT.** — Prophylactic measures during the acute stage of any infectious disease capable of causing acute thyroiditis should not be neglected. The thyroid should be watched and if it becomes sensitive

or swollen **cold compresses** should be applied over it, and **saline solution** be either administered internally or per rectum and retained as long as possible to favor absorption. The absorbed solution, by reducing the viscosity of the blood coursing through the organ, favors resolution.

[As I have pointed out, the main cause of the lesions in the thyroid is the excessive proteolytic activity of the thyroidal blood, owing to the fact that the organ is the source of a substance which, by promoting the thermogenic power of the lecithin which the blood cells contain, increases the proteolytic activity of the enzymes. The bacteria are thereby sensitized and digested by phagocytes and the plasmatic antibodies. When, however, this process becomes excessively active owing to the presence of a multitude of bacteria, the delicate tissues of the organ are themselves sensitized and subjected to proteolysis. Hence the miliary abscesses, which are in reality minute areas subjected to autolytic destruction. **Cold**, by reducing the proteolytic activity—due to ferments—of the antibodies in the organ, reduces the damage done; while **saline solution**, by reducing the viscosity of the blood and facilitating osmosis, also reduces its digestive power. C. E. DE M. S.]

Edema of the glottis should be met by the local application of a 10 per cent. solution of **cocaine** and a 1:2000 solution of **adrenalin**, equal parts, and if this proves insufficient the edematous tissues should be incised with the curved bistoury, duly protected to near the tip of the blade. If the pressure of the inflamed organ on the trachea is such as to threaten suffocation, intubation—or if the pressure is too low to be reached by the tube, tracheotomy — is indicated. **Partial thyroidectomy** sometimes becomes necessary.

Two of the writer's patients developed suppurative thyroiditis following puerperal infection, 2 after influ-



enza, 2 after pneumonia, and 1 after an influenzal bronchopneumonia. In one case suppuration occurred without apparent cause. In one case the writer merely drained the thyroid by **incision**. In another he incised and **curetted**. In the latter, the thyroid was calcified and substernal. In 3 cases he removed the gland after drainage had been instituted by another surgeon, or after the suppurative process had ruptured. In 3 others he performed a **primary thyroidectomy**. Viannay (Lyon chir., xx, 820, 1926).

The writer treated with **anti-typhoid vaccine** a case of intense thyroiditis, involving adjacent glands, in the course of typhoid fever. After 2 doses of 0.5 c.c. of the antityphoid vaccine, at 4 days' interval, the thyroid and other glands subsided to normal size, and the patient recovered rapidly. In the 16 cases of typhoid thyroiditis collected, 50 per cent. had a pre-existing goiter. Operative measures were required in 13 cases. Sabrazès, Sainte Marie and Alain (C. r. Soc. de biol., Jan. 23, 1925).

Another pernicious factor in this condition is a high blood-pressure. Vascular depressants such as **chloral hydrate** may be used with advantage. The **tincture of veratrum viride** may also prove useful. Care should be used lest too great depression be produced. Absolute **rest** is imperative. Suppuration calls for an exploratory **incision** and evacuation of the abscess. The multiplicity of small abscesses sometimes demands **removal of the affected area**. According to Kocher, the presence of a fistula points to extensive necrosis of the organ.

The underlying cause should influence the treatment. If thyroiditis develops in the course of rheumatism, **salicylates** are indicated; in the course of malaria, **quinine**. **Ice** may be helpful for the pain. The internal

use of **iodine preparations** is especially to be avoided.

### ACUTE STRUMITIS.

Acute strumitis, *i.e.*, acute inflammation of a goiter, may be caused by the invasion of bacteria and their toxins, brought to the goiter by the circulating blood in the course of various infections, particularly those which are seemingly benign: tonsillitis, laryngitis, bronchitis, and ulcerative nasal disorders, enteritis, etc.; though as in acute thyroiditis, the more serious disorders—typhoid fever, diphtheria, lobar pneumonia, polyarthritides, puerperal sepsis, bacillary and amebic dysentery, Asiatic cholera, and other infections—may likewise provoke it, chiefly toward their close. Pathogenic bacteria seem to have an affinity for cysts and degenerated nodules. Traumatism, punctures, even such as are practised when therapeutic agents are injected into a goiter, may also cause strumitis. It has also been ascribed to poisons, constituting the form known as "toxic strumitis."

**SYMPTOMS.**—Acute inflammation in a goiter manifests itself by a sensation of discomfort in the mass and a chill, soon followed by local pain and marked sensitiveness to pressure. Then appear fever, headache, and the most distressing symptom of strumitis: dyspnea, sometimes threatening asphyxia. This is due to pressure of the swollen goiter upon the trachea, or to impaction of the mass between the sternum and the trachea, complicated often with edema of the larynx.

Dysphagia may also be marked and painful, each bolus in passing along the esophagus exerting pressure upon

the inflamed gland. Radiating pain in the neighboring structures up to the occiput or down the arms, owing to pressure of the inflamed growth on nerves, is sometimes complained of. Hoarseness is frequent from the same cause, or as a result of glottic edema. If no pus be present, the inflammation tends promptly to subside.

When suppuration occurs the fever may assume the hectic type, with exacerbations and severe malaise and prostration. When this occurs in connection with a general infection, the prognosis of the latter may be markedly aggravated.

The inflamed goiter may become elastic and fluctuate if the abscess is large, which is often the case in strumitis. It may rupture into the surrounding tissues, open into the trachea, esophagus, the larger vessels, or, again, burrow down into the mediastinum, the lungs, pleura, etc., with its attendant dangers, or upward along the sheaths of the great cervical vessels. It may, however, open externally, to the great relief of the patient. Occasionally a small abscess is absorbed.

**DIAGNOSIS.**—The only condition with which the strumitis may be confused is malignant growth, when softening, suppuration, and cachexia are prolonged. The course of cancer is not as rapid, however, and cultures and examination of fragments of the growth will usually establish the identity of the condition present.

**PROGNOSIS.**—The progress of the morbid process is governed by the intensity of the infection. Suppuration invariably prolongs the case, but if the abscess can be reached and evacuated the acute symptoms promptly subside.

A persistent abscess or a collection of them entail the dangerous phenomena enumerated above, which may cause death. Surgical measures, therefore, are indicated to save life.

**TREATMENT.**—The treatment is precisely the same as that recommended for acute thyroiditis, viz., **cold compresses** locally, and **saline solution** by the mouth or rectally to reduce the viscosity of the blood coursing through the organ. **Chloral hydrate** or **veratrum viride** used with care is advantageous to reduce the congestion of the organ, the former also acting as an analgesic by favoring sleep.

If symptoms indicating suppuration occur, the **abscess**, if single, which is more frequently the case in strumitis than in acute thyroiditis, should be carefully located and evacuated. Kocher advocated **excision** of the goiter in such patients, if the surrounding tissues are not involved in the suppurative process. The operation should be preceded by an **exploratory puncture** and examination of the fluid, pus, etc., contained in the organ to ascertain that the bacteria therein, particularly the colon bacillus or the *Staphylococcus albus*, are non-virulent. The pus should first be removed by **aspiration** and an antiseptic solution injected into the cavity. When the abscess has extended to the surrounding tissues, the sphacelous areas should be opened with the **galvanocautery** and the pus **evacuated**. The cavity should be washed out rather than cleared with the curette or with the finger, which may provoke dangerous hemorrhage.

**PREVENTION OF GOITER.**—Goiter prophylaxis by the administration of small quantities of iodine

has been resorted to for several decades in Switzerland, France and Austria, in particular, with good results. In this country, Marine and Kimball, in 1917, carried on investigations which gave goiter prevention a solid foundation. They gave about 2000 school girls doses of iodine just sufficient to saturate the thyroid in the spring and fall, while an equal number, 2000, who took no iodine, were watched concomitantly. None of the girls who took iodine developed goiter, while those who were given no iodine showed evident goiter in the high proportion of 26.7 per cent. Again, those who had goiter found that the systematic use of iodine caused the mass to recede in 60 per cent. to normal. A systematic study of the dosage required has shown that minute doses—10 milligrams ( $\frac{1}{6}$  grain) weekly, administered in chocolate-coated tablets of iodine in organic form, gave the best results.

The drawback of this method has been the danger of provoking toxic goiter in non-toxic goiters of long standing, particularly in subjects over 20 years of age. Kimball has called attention to the fact that even the use of the iodized salt, sold promiscuously in all parts of the country, regardless of the harm it may do, might be evoking hyperthyroidism in cases of toxic adenoma. The abuse of iodine as a cause of hyperthyroidism has been emphasized by A. L. Jackson (Journal-Lancet, June, 1924), C. L. Hartsock (Jour. Amer. Med. Assoc., May 1, 1926), and others.

In two personal cases of toxic goiter under medical treatment progress was unusually slow until the discovery was made that the patients were using iodized salt. On discon-

tinuing the latter, rapid improvement followed. Hartsock cites two similar experiences after thyroidectomy.

This does not mean that the administration of small amounts of iodine, not more than 30 grains (2 Gm.) of sodium iodide twice yearly, is not prophylactic. Considerable evidence to the effect that it is so, is available. But this should be limited to subjects—both in children and adults—who are free from goiter. Whenever such a growth is observed, careful examination by a physician to determine whether the goiter be a colloid with basal metabolism rate normal or below is indicated. In such an event, iodine prophylaxis can only prove beneficial. Where, however, the basal metabolism is above normal, no iodine should be given prophylactically.

C. E. DE M. SAJOUS,

Philadelphia.

**GOLD.**—One preparation of gold was formerly official: *Auri et sodii chloridum* U. S. P. IX (chloride of gold and sodium). Dose  $\frac{1}{80}$  to  $\frac{1}{10}$  grain (0.002 to 0.006 Gm.).

*Sodium aurothiosulphate* or *sanocrysin* has been advocated in tuberculosis by Mollgaard, who finds it superior to other gold preparations in being readily diffusible and slowly decomposed in the body without directly giving off toxic substances. Deaths have, however, occurred under this treatment, even in mild cases.

*Colloidal gold* preparations are advocated by some in severe acute infections. Conterno injects intravenously 1 to 5 c.c. (16 to 80 minims) of a preparation containing 0.1 per cent. of gold and has observed a resulting pronounced lymphocytosis.

**PHYSIOLOGICAL ACTION.**—The chloride of gold is a caustic irritant. In small medicinal doses the preparations of gold sharpen the appetite and promote digestion. If long continued, symptoms of overstimulation follow their use. Con-

stipation is usually present. The mental functions become more active. Increased venereal desires are attributed to the use of gold. In men priapism is not uncommon. In women the menses are increased.

**POISONING BY GOLD.**—The acute form of poisoning follows the ingestion of a toxic dose and manifests itself by a violent gastroenteritis, accompanied by cramps, convulsions, trembling, insomnia, priapism, and insensibility.

In the chronic form of poisoning by gold there develops a fever accompanied by sweating, a very abundant flow of urine, and salivation, without tenderness or ulceration of the gums, epigastric heat and oppression, headache, dryness of mouth and throat, with gastrointestinal irritation.

**Treatment of Acute Poisoning by Gold.**—The principles of treatment are the same as poisoning by corrosive sublimate. The contents of the stomach should be evacuated after the free administration of albumin, eggs, milk, and flour. External heat should be applied and stimulants administered by the mouth, the rectum, or by hypodermic injection. Morphine is useful if shock is present. Atropine will diminish the salivary secretion, and astringent (tannin) or dilute-acid mouth-washes will relieve the salivary symptoms.

**THERAPEUTICS.**—The preparations of gold are not as much in favor as formerly. Indigestion is relieved by small doses ( $\frac{1}{80}$  to  $\frac{1}{24}$  grain—0.0011 to 0.0027 Gm.) given three times daily. Mills regards it as a valuable tonic in hysteria and other disorders dependent upon depravity of the nervous system. Magruder has extolled its effects in pertussis.

**Genito-Urinary Disorders.**—In diseases of the internal organs associated with sclerosis, as nephritis, cirrhosis of the liver, etc., the persistent use of gold and sodium chloride has given excellent results. In contracted kidney a pill of chloride of gold has been recommended by Dana. It has been found of considerable value as a stimulant in impotence, and in the seminal emissions due to masturbation or general asthenia.

**Phthisis.**—Gibbs and Shurly, of Detroit, laboring under the impression that

gold and sodium chloride possessed bactericidal powers in this disease, reported a number of cases in which satisfactory results were obtained.

The writer treated 5 cases of pulmonary tuberculosis, free from fever and other complications and with doubtful prognosis, with intravenous injections of potassium and gold cyanide by the method recommended recently for lupus. The initial dose was 1 c.c. (16 minims) of a 1 per cent. solution, thoroughly diluted with saline solution. A therapeutic effect is undoubted, yet it is generally better to employ much smaller doses, which give rise to no temperature elevation. Junker (Münch. med. Woch.; Charlotte Med. Jour., Dec., 1913).

**Syphilis.**—In old secondary and tertiary cases where mercurials and the iodides have been long in use, gold will yield beneficial results, as in gummata, syphilitic pharyngeal ulcerations, specific ozena, etc. Ingals has found gold chloride valuable in syphilitic laryngitis. Hale White finds the gold and sodium chloride preferable to corrosive sublimate in the tertiary form, especially when the osseous system is involved.

**Effusions.**—Gold has yielded good results in ascites due to chronic hepatitis, post-scarlatinal dropsy, and in ovarian dropsy.

**Gynecological Disorders.**—Amenorrhea, sterility due to coldness, ovarian torpor, and the tendency to habitual abortion have been benefited by the use of chloride of gold.

**Mental Disorders.**—Good results have been obtained from the use of gold in melancholia and hypochondria accompanied by depression. Vertigo, when due to gastric disturbance, is often relieved by small doses of gold chloride, but when cerebral congestion or plethora is present, the use of gold is contraindicated.

**Inebriety.**—Chloride of gold has been recommended in the treatment of chronic alcoholism but mainly by empirics. W.

**GONORRHEA.** See URINARY AND GENITAL SYSTEMS, SURG. DISEASES.

**GONORRHEAL ARTHRITIS.**

See RHEUMATISM, GONORRHEAL.

**GONORRHEAL OPHTHALMIA.** See CONJUNCTIVA, DISEASES OF.

**GONORRHEAL RHEUMATISM.** See RHEUMATISM.

**GONORRHEAL VAGINITIS.**

See VAGINA AND VULVA, DISEASES OF.

**GOUNDOU** (Anakhre, Henpue, or Big-nose) is a tropical disease peculiar to negroes, characterized by the development on each side of the nose below the eyes of osseous growths rounded in shape. At first there is severe headache, a sanguino-purulent discharge, and a slight bean-like swelling which forms the basis of the growth. As the latter increases, it may interfere with vision simply by obstructing its field; it may also at this stage compress the nostrils and interfere with respiration. The tumors themselves are painless and the overlying skin remains normal.

Aside from Africa, cases have been reported from the West Indies, Malaya, Sumatra, China and Brazil.

First case of goundou to be reported in Brazil. In this case, a mulatto aged 24, the tumor was found just on the left side of the nose, spreading over the superior maxillary bone. It grew painlessly, and he remained perfectly well. The bony outgrowth was scraped off, and pathologically seemed to be an osteoma. Mendes (*Revue de Chir.*, Oct., 1901).

Case of goundou in a Portuguese aged 53 who had lived in Brazil since 1892. Operation was refused. Not over 3 cases in Brazil have been recorded. Mendes (*Brazil-med.*, June 13, 1925).

**ETIOLOGY AND PATHOLOGY.—**

Goundou has been ascribed to many different causes: a sequel of yaws (Chalmers); a disease *sui generis* (Braddon); a trophic neurosis (Mendes); an example of atavism in the negro (Strachan); malformation due to the non-union of the nasal and frontal bones (Kleng); the presence of the larvæ of insects in the nostrils (Mac-laud). According to Wellman, none of the

explanations proposed rests on anything more than conjecture. The tumors are doubtless a hyperplasia, probably an osteoplastic periostitis due to a definite but undiscovered cause.

**TREATMENT.**—Medicinal treatment is useless, but surgical removal of the growths is readily effected and is not followed by recurrence. S.

**GOUT.—SYNONYMS.**—Podagra; arthritis urica.

**DEFINITION.**—Gout is a constitutional disease associated with an accumulation of uric acid and other purin bodies in the blood and tissues, manifesting itself in various ways and attacking various tissues and parts of the body, but most frequently the articulations. It occurs in an acute and a chronic form, both of which are characterized by the deposit of urates in the affected parts.

A separate condition termed "calcium gout," featured by extensive calcification in some parts of the body through absorption of calcium from bone, and usually associated with nephritis, has been described.

Gout is regarded by the author as purely hereditary and as being based on a tendency to cellular sensitization. This may remain latent, or may become clinically manifest as a result of the presence of the corresponding protein or antigen, whether of animal, vegetable, bacterial or other nature. The local effects are exerted through the medium of vascular endothelial poisoning, with local ischemia and venous stasis. Where these effects are not exerted on the joints, there occur such irregular manifestations as asthma, urticaria and eczema. Llewellyn (*N. Y. Med. Jour.*, Nov. 21, 1923).

**SYMPTOMS.**—An attack of acute gout may occur without any precursory symptoms in persons who, before, felt quite well; but this mode of development is not usual. Generally,

premonitory signs are experienced some time in advance, especially in the digestive and circulatory system and in the kidneys. The patients have frequently led a luxurious life; have been accustomed to excessive consumption of food, especially of animal food; have indulged in alcoholic drinks, and taken little or no exercise. They are often obese, with red and flushed face, and complain of heartburn, sour eructations, flatulency, and other indications of a dyspeptic derangement. Another form of gout—poor man's gout—is met with in persons living badly and exposed to cold and dampness; these patients are ordinarily lean, with sallow faces.

Immediately before an attack of acute gout the dyspeptic symptoms become aggravated; the bowels are obstinately confined; hemorrhoidal pains and hemorrhage are observed. The patients complain of headache, vertigo, drowsiness; sleep is disturbed by pain or cramps in the calves and elsewhere; there is pain in various articulations, parasthetic sensations, such as numbness of the fingers, chilliness, etc.

Irregularity of the action of the heart is often observed and the pulse is ordinarily firm and tense; the morbid state of the nervous system manifests itself by mental depression, irritability, bad temper; severe neuralgia is a frequent precursory symptom, and severe pains of the lumbar region are frequently complained of. In spite of all these manifestations, the appetite is generally good and the venereal desire is frequently increased. The urine is in most cases concentrated and scanty; in others the micturition is free, acid, and

abundant, the urine being clear and watery. Just before the attack all the precursory symptoms commonly disappear and a general sense of well-being may be experienced.

Although some of these precursory symptoms are observed in most cases, an attack of gout may well occur without warning; when the first attack sets in, the patient may believe that he suffers from a sprain of the affected joint or that the pain is of rheumatic nature and only by repetition of the attack does the real nature of the disease become apparent.

In the majority of cases of acute gout the metatarsophalangeal joint of the great toe is the articulation first attacked, generally on one side, but sometimes on both; in subsequent attacks other articulations become involved, either of the foot (podagra) or of the hand (chiragra). Almost all articulations may successively or simultaneously be affected, even the articulations of the jaw and of the spine; the hip-joint and the shoulder-blade are very rarely affected.

The attack itself has been vividly described by Scudamore, Sydenham, and other classics of gout: "The patient has gone to bed without any particular disturbance of health and often feels better than for some time; after some hours' sleep he is awakened, ordinarily between 12 and 3 o'clock, by a very intense pain in the great toe. The attack sometimes begins with a slight rigor. The pain soon increases to complete agony; there is much restlessness, and in vain some relief is sought by changing the position of the foot. The patient complains of extreme tension and throbbing in the affected joint; the pain, which has been compared to

that caused by a tightly drawn thumb-screw, is aggravated by the slightest touch or vibration, and becomes so intense that nothing at all like it occurs in any other joint disease.

"After some hours of this excruciating pain, some relief is obtained, coming gradually or quite suddenly, perspiration occurs, and sleep follows. On the following day the affected joint is found swelled, red, tense, shining, and tender. Some pain continues all the day, and toward evening it becomes aggravated, reaching almost the same intensity as in the preceding night." The temperature is somewhat elevated; it reaches 102° F. (38.9° C.), but seldom higher; the pulse varies from 80 to 100.

For some days the symptoms may recur in the same manner, then some edema appears around the affected joint, and successively increases to the fourth or fifth day, when the pain finally commences to decline; the swelling of the affected joint then diminishes, and this is commonly followed by cracking and peeling off of the cuticle: a process accompanied by intense itching. When the great toe-joint or similar small articulations are affected no effusion in the joint can be felt; when larger articulations, such as the knee-joint, are attacked, this sign is frequently observed.

During the attack there is commonly thirst, but no appetite; the patient feels even aversion to solid food, and some nausea; vomiting occurs rarely; the tongue is furred and the bowels constipated, or there may be some pale and offensive stools. The urine is scanty, concentrated, and a copious sediment of urates and uric acid crystals is precipitated.

When the attack has passed away, the patient often feels better than before it; some weakness, tenderness, and stiffness of the affected joint remain for some days; then complete recovery is established. The duration of the whole attack varies from six to ten days, and may even reach some weeks; in that case there are numerous remissions and exacerbations of the attack.

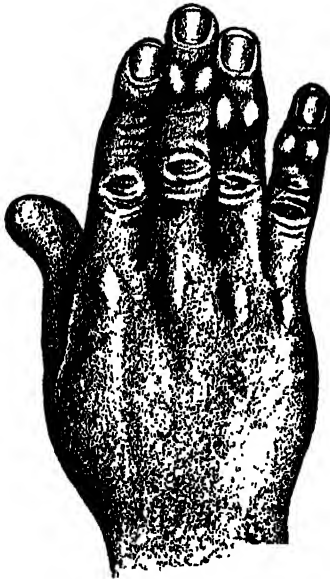
All attacks of acute gout do not, however, pass off suddenly; they may supervene gradually and increase in severity until they reach the true classical form. Sometimes the first attack is more violent, but as the malady progresses the accesses become more prolonged and are not so painful; at first the attack generally comes on once a year,—in the spring; then twice a year,—in spring and autumn; afterward at more irregular intervals. Only rarely does the malady show itself by one attack only; that may occur when the patient alters his whole manner of life, renounces the use of alcoholic stimulants, lives on very frugal diet, etc.

As the attacks become more frequent, asthenia increases, the pain is less violent, the duration of the access is longer, the stiffness of the affected joints does not completely disappear, and they remain enlarged, red, and tender even after the attack has passed away; smaller or larger hard nodules (tophi) are found in the tissues around the joints and elsewhere,—the case is passing over into the chronic stage.

As already stated, the first attack of acute gout ordinarily affects the metatarsophalangeal articulation of the great toe; in some cases the knee or the elbow-joint is attacked at the

onset. Garrod and other authors state that an injury, such as a sprain or a contusion, may determine the localization of the gouty process to the injured joint. Charcot observed that the articulations of paralyzed extremities were particularly liable to be involved by gout.

**Chronic Gout.**—Chronic gout may occur as the result of a long series of acute attacks which gradually have



Gouty fingers. (Pfeiffer.)

weakened the constitution of the patient, or it may appear in feeble subjects as the only manifestation of gout. In both cases the joints successively get enlarged, deformed, stiff, —even immovable,—nodulated, owing to the deposition of urates in their structure. The skin covering them is congested and thin, with large, blue veins; ultimately it may rupture, and discharge whole chalky masses of urates,—tophi,—sometimes followed by suppuration and ulceration. The deformities of hand and foot are caused by partial dislocations of the

phalanges, with deflection of the fingers in various directions; when the affected articulations are moved, a scraping sound is heard and felt. In the most advanced cases not only fingers and toes, but also wrist and elbow, ankle-joint, and knee, are stiff and deformed, and at last the patient may be obliged to remain immovable in his chair or in his bed as an impotent cripple.

In chronic gout urates may be deposited in different structures, such as tendons (especially the tendo Achillis), bursæ, aponeuroses, and periosteum; in the cartilages tophi may be found, very frequently in the ear, but also in the eyelids and on the nose. These tophi are generally of the size of a pin's head or a bead; at first they contain a whitish fluid containing crystals of urate; ultimately they become solid and form small, hard nodules.

In the skin tophi are more rarely found, but have been observed in the face. The urine in chronic gout is ordinarily pale and watery, sometimes slightly albuminous, and commonly abundant; it contains always casts of renal tubuli, hyaline or granulated. The patients are weak and pale, suffering from disorders of digestion; they are subject to cramps, neuralgias, and other nervous disorders.

**Irregular Gout.**—Besides the symptoms directly dependent on or associated with the deposition of urates in the articulations and in other structures, many morbid symptoms have been observed in the course of gout and have more or less correctly been named symptoms of irregular gout; these symptoms may alternate with the regular attacks, and their



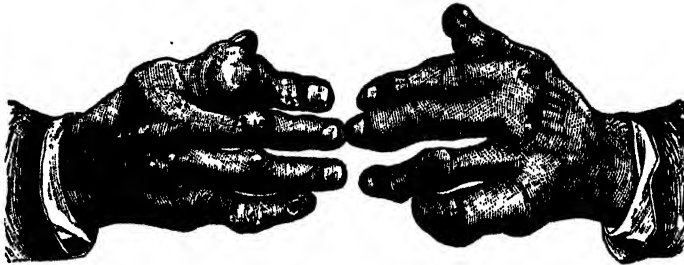
gravity is frequently in inverse proportion to the violence of the true gouty attacks. Symptoms of irregular gout may occur,—an imperfect development of the attack, or suppressed gout; or when inflammation of the joint from some cause or other (improper treatment) unduly subsides, retrocedent gout.

Almost all internal organs may become the seat of disorders which have been ascribed to gout.

The gouty kidney presents the same signs as the ordinary granular-atrophic kidney, and cannot be dis-

pression, epileptic fits,\* and apoplectic attacks. All kinds of neuralgia, especially gouty sciatica and costal neuralgia, have been described, and symptoms of disorders of the spinal cord and the meninges and paresis or paresthesia at the peripheral nerves have also been noted.

The vascular disorders are generally caused by atheromatous changes of the large vessels and followed by hypertrophy and fatty degeneration of the heart. Severe palpitations, intermittent and irregular cardiac action, and weak, very slow or rapid



Gouty fingers. (Pfeiffer.)

tinguished from it, neither by the symptoms nor by the anatomical examination. It will be shown later on that a certain degree of granular atrophy of the kidney is found in all cases of gout; when the renal changes are fully developed, the urine becomes clear and watery, contains urea and uric acid and in deficient quantity, and the patients may die from renal insufficiency. Gouty persons often suffer from gravel and calculosis; oxaluria is frequently met with; chronic cystitis and urethritis may be observed, especially in old persons suffering from gout.

In the direction of the nervous system many symptoms of morbid derangement may be observed, such as headache, hemicrania, vertigo, fainting, sudden delirium, mental de-

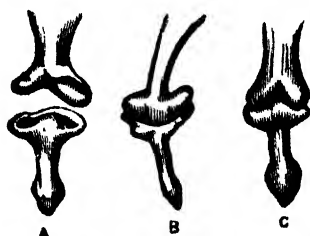
pulse are frequent symptoms in gout. There may be dyspnea and a feeling of constriction, and true attacks of angina pectoris are not uncommon. Phlebitis, especially of a recurrent form, has been observed among the symptoms of gout by competent observers.

Although the digestive system is very commonly deranged, the stomach and the bowels are not liable to specific gouty changes; fatty liver and a tendency to cholelithiasis are frequently observed; severe pain in the stomach or in the bowels may occur, but these seem to be of neuritic origin.

There are groups of symptoms in gout which certainly have no connection with uric acid. They include dyspepsia, skin diseases, myalgia and

neuralgia, arteriosclerosis, and granular atrophy of the kidney. These and other phenomena observed suggest that the disturbance in the purin metabolism is not the true essence of gout, but is merely one symptom of a more general disturbance. W. His (Deut. med. Woch., April 15, 1909).

In chronic gout, in the absence of acute symptoms, and with patients on a purin-free or nuclein-rich diet, there is no profound change in the intermediary metabolism as compared with that of a non-gouty person. These negative findings do not exclude the possibility that in gout there is (1) a disturbance in the metabolism of the nucleins, (2) or a disturbance in some other phase of the intermediary metabolism, (3) or a



Osseous enlargement in gout. *A* represents the phalanges from the back, and *B* the side view. For purposes of comparison a delineation is given of the dorsal surface of a normal phalangeal joint, —shown in *C*. (Pfeiffer.)

disturbance in some minor phase of intermediary metabolism due to nuclein foods. Wentworth and McClure (Arch. of Int. Med., Jan., 1918).

The skin is frequently affected. Among the diseases of the skin allied to gout may be named erythema, eczema, urticaria, psoriasis, prurigo, and acne.

Bronchitis and asthma are often met with in gouty patients; there seems to be a certain antagonism between gout and tuberculosis; at least, it has been asserted by many authors that tuberculous changes develop very slowly in gouty patients.

Obesity and diabetes mellitus are often associated with gout. Uratic

deposits have been found in the cornea and conjunctiva; uratic keratitis and iritis and gouty inflammation of the vitreous body have been observed.

When uratic deposits occur in the mastoid cells or in the cecum tympani they may cause deafness.

Rhinitis and parotitis urica have been mentioned, and also xerostomia, *i.e.*, extreme dryness of tongue and mouth lasting for months. Throat inflammations and esophagismus have likewise been noted.

The urine of gouty patients is of varying aspect and nature; in persons disposed to gout the urine is ordinarily concentrated, loaded with urates, and a sediment of urates and uric acid is deposited; during the gouty attack the urine presents commonly the same character. In other cases the urine is pale and watery; there is diminution of its principal components, and traces of albumin may be found. In "poor man's gout" and in chronic cases which have weakened the constitution of the patient the watery, pale urine is frequently observed.

From the investigations of Vogel, Schmoll, Laquer, and Magnus-Lévy it appears that before the attack and in the free intervals between them nitrogen is constantly retained in the body, whereas during the attack this is reversed, urea and also uric acid (His, Pfeiffer) being excreted at this period in quantities even exceeding the normal.

As already mentioned, a slight albuminuria may be occasionally found; but even if that be not the case, symptoms of a disease of the kidneys are never failing in gout. One of us examined many samples of urine from gouty patients and found that

by the use of a centrifugal apparatus and a microscope we were always able to detect hyaline and granular casts in it, and are of the opinion that this indication of a morbid state of the kidneys is a constant symptom of all stages of gout.

**DIAGNOSIS.**—The diagnosis of a typical attack of gout is easy not only as regards the localization of the morbid process, but also as to the development of the affection. Chronic gout may be confounded with other chronic affections of the joints of gonorrheal, tuberculous, or neuropathic origin. Generally the diagnosis is facilitated by the clinical history of the complaint and by the examination of the affected articulation. In acute gout there are the unmistakable symptoms produced by an attack of podagra; in chronic gout the presence of tophi in the joints, ears, forearms, and other parts of the body will lead to the diagnosis.

Study of familial eosinophilia has cleared up the conception of the gouty and the neuroarthritic diatheses, asthma, urticaria, etc. These are all the result of a constitutional abnormal condition of the vegetative nervous system. This is manifested usually by a constitutional and familial eosinophilia. It may be further manifested by asthma, hay-fever, urticaria, epilepsy or gout, these being all clinical equivalents in adults; children are liable to present the exudative diathesis. Asthma and hay-fever, as well as gouty joints, are thus explained as a nervous-gouty catarrhal state. The acute attack of gout is an acute trophoneurosis. The most serious localization of the gouty tendency, however, is in the kidneys, and this adds, secondarily, a new element to the pathology of gout, namely, retention of uric acid. The mistake has been made that this uricacidemia is assumed to be the cause of gout, when

in fact it is secondary to the neuroarthritic diathesis. The retention of uric acid sets up a vicious circle between the attacks of gout; urticaria may result as an equivalent of the acute attack of gout. In the intervals between the attacks of gout, if the elimination of uric acid is below normal, we can assume that the kidneys are already more or less pathologic. Asthma, hay-fever and gout are more common in men than in women, possibly because the *thyroid* seems to function less in the male. In women the gouty tendency becomes more manifest at or after the menopause, when the thyroid may be supposed to become less active. Falta's report that the elimination of uric acid is usually low in exophthalmic goiter fits into the argument. Klinkert (Jour. Amer. Med. Assoc., from Nederl. Tijdsch. v. Geneesk., Dec. 8, 1917).

It is often difficult to distinguish between the chronic gouty affection of a joint and the morbid change caused by rheumatoid arthritis,—or, as it is more properly called, the polyarthritis deformans,—which disease attacks the cartilages, as well as the bone, and leads to destruction of the cartilage, to proliferation and thickening of the ligaments, and frequently to growths of osseous protuberances. In this malady there is no trace of uratic deposits.

The chief points of difference between gout and polyarthritis deformans are the following: In gout hereditary predisposition is commonly observed; the disease occurs more frequently in the better classes than among the poor; it is most prevalent among males; in the clinical history there is often a record of abuse of alcoholic stimulants, beer, or strong wines; the patient may suffer from lead poisoning.

In many cases the appearance of

gout has been preceded by repeated attacks of renal colic or by long-continued evacuations of uric acid sand.

Frequently (but by no means always) gout begins with an acute attack. The urine is usually found deficient in urea and uric acid, while upon centrifugation and examination of the sediment with the microscope, casts, hyaline or granular, will always be detected in quantities more or less great.

An examination for tophi should be made, especially in the external ear, where they are most likely to be found. Generally they are superficial and whitish. If there is doubt as to whether tophi or merely small fibroid nodules or sebaceous cysts are present, puncture and microscopic examination of evacuated contents for characteristic needle-like crystals of sodium biurate is justified. Similar examination for crystals, after excision, is applicable in the case of the subcutaneous tophi mentioned by Fitcher as occurring over the extensor surfaces of the forearms and about the knees, and as being likely to be mistaken for rheumatic fibroid nodules unless microscopically studied. Heberden's nodes on the terminal phalanges are much more suggestive of arthritis deformans than of gout. Ulnar deflection of the fingers and atrophy of the dorsal interossei also point to arthritis deformans.

Where several joints are involved, absence of fever is indicative of acute gout in contradistinction to acute rheumatism. A leucocytosis is the rule in acute gout. The presence of local edema when the acute attack subsides is likewise significant.

Complicating nephritis or arteriosclerosis is a common feature of gout.

Early knowledge of a tendency to renal deficiency may be obtained by such procedures as the phenol-sulphonphthalein test, the water excretion test, and the urea concentration test.

As for clinical studies relating specifically to uric acid, some assistance may be obtained by tracing the curve of uric acid elimination in the urine before, during and after an acute gouty attack, or by the observation of a delay in uric acid excretion as compared to the norm when the patient is first placed on a purin-free diet for several days, then given a known amount of purin for test purposes; in the gouty subject the resulting elimination of uric acid is likely to be spread over a period of 3 to 5 days. More highly regarded, however, are determinations of the uric acid in the blood, especially after a temporary purin-free diet. The determinations are usually made by the method of Folin *et al.*, based on colorimetric measurement of the deep blue color produced when uric acid is brought together with phosphotungstic acid and sodium carbonate. Before the test can be made with the blood, freeing of the latter from protein is required. Folin and Denis have called attention to the advantage of simultaneous estimation of the non-protein nitrogen as a diagnostic aid, since in gout it is rarely increased, while in arthritis it generally is. Again, in nephritis, increase in the non-protein nitrogen may be unaccompanied by any notable increase of uric acid.

The X-rays have been used as a means of diagnosis. Uric acid compounds are practically transparent to the rays. In a Röntgen photograph of

a hand or foot affected by gout the clear lines between the bones indicating the articulation appear quite unaltered, and the extremity resembles very much a healthy extremity and differs only from it by the enlarged outlines of the fingers and toes. Large deposits, such as tophi, are quite invisible in X-ray pictures.

The X-ray reproduction of a hand or foot affected by polyarthritides deformans presents quite a different aspect; all the articulations affected by the disease, even if it be not developed far enough to cause stiffness or enlargement of the joint, have lost their clear, transparent appearance, and are of a darkened, almost black color. When the joint has been affected for some time, it is impossible to discern the exact level of the joint; the bones seem fused together, even in cases where a rather good mobility of the joint still exists.

In some gouty cases there is visible a punched-out appearance in the articular surfaces or shafts of the terminal phalanges, ascribed to bone absorption and replacement by urate deposits.

Vacuolation in the bones of the fingers or toes, as seen in X-ray pictures, is at times the only clinical evidence of gout, thus pointing the way to proper treatment. This sign proved useful in an alcoholic patient who had been treated ineffectually for neuritis for 5 months. Two other illustrative cases described. Weil and Debré (*Presse méd.*, Mar. 18, 1925).

When all these facts are united, the clinical history, the examination of the joint and of the urine and blood, and the aspect of the Röntgen photograph of the affected parts, the diagnosis will in most cases offer no insuperable difficulty.

**ETIOLOGY AND PATHOGENY.**—Gout is a markedly hereditary disease affecting men much more frequently than women. As it often occurs in subjects having presented indubitable signs of gravel or uric acid calculi, it seems to be in some way related to that complaint; it has often been observed that, in a family disposed by inheritance to gout, cases of this malady alternate with cases of uric acid gravel or calculi; hence the conclusion was drawn that both diseases had a common origin: the uric acid diathesis.

Developed gout is rarely met with before the thirtieth and fortieth years; it begins rarely after the forty-fifth year, but may in hereditary cases even affect children.

Persons who live freely, eat much meat, indulge in alcoholic drinks, and take little or no exercise are most subject to the disease; but it may also be observed in nervous, lean, underfed subjects, especially when they take much ale or porter and by their employment are exposed to cold and dampness. All sorts of excesses and overwork, bodily or mental, seem to be apt to provoke the attack of gout. Sydenham states that he always had an attack of gout following prolonged mental labor.

Workmen employed in lead-mills, painters, plumbers, and all persons exposed to absorption of lead are extremely disposed to be attacked by gout (Garrod, Lancereaux, and others).

The disease prevails chiefly in cold and temperate climates, especially when the latter are at the same time damp and changeable; gout may, however, be found also in countries where the climate is warm and equable.

Cantani found it to be not uncommon in Naples, and it is frequently observed among the Arabs of Algiers.

Indulgence in alcoholic drinks and excessive consumption of animal food predisposed to gout; it has therefore been called a disease of the well-to-do classes. Of alcoholic drinks, wines containing a large percentage of alcohol—such as sherry, port, and champagne—have the worst effect; the lighter wines—as claret or Rhine wine—are not so hurtful. Among the malt-liquors ale and porter are reputed to be much more conducive to the development of gout than the lighter kinds of beer; distilled alcoholic beverages—such as gin, brandy, and whisky—are by many authors believed to be less liable to cause the development of gout than beer or strong wine.

Although gout is a malady which has been known to physicians for thousands of years, its pathogeny and real nature are still a subject of debate.

As already stated, the deposition of urates in different structures is the most characteristic feature of gout; the origin of these deposits has consequently been investigated by many observers.

Garrod, in his celebrated work on gout, demonstrated that the blood of gouty patients contains more uric acid than in the normal state.

[This was done by mixing a few cubic centimeters of blood-serum or fluid from a blister with 10 or 12 drops of acetic acid. Threads of cotton were placed in this mixture; this was covered by a watch-glass and left alone for from twenty-four to forty-eight hours. After that space of time the thread was thickly covered with characteristic crystals of uric acid, when the blood was taken

from a gouty patient, especially immediately before an attack. The blood of healthy persons or of patients suffering from diseases not accompanied by uricemia does not give the same results. F. LEVISON.]

The experiments of Garrod have been repeated by other observers, and it is now generally accepted that in gout, uric acid, in the form of urate of soda, is found in the blood in excess. Different questions now arise: How and where in the body is the uric acid formed and what is its physiological significance? Which is the uric acid compound circulating in the blood and excreted in the urine, and how are these deposited to form tophi, etc.? What is the origin of the uricemia in gout, and, if uric acid may also be found in excess in the blood in other diseases, why are deposits of uric acid compounds only formed in gout?

The first question was, until the last few years, generally answered by the statement that uric acid, as well as urea, were products of the metabolism of proteids; the normal result of the complete oxidation of these was urea, only a small amount of proteids being left in a state of lower oxidation and excreted as uric acid. In some persons suffering from a slow and incomplete metabolism—retardation of metabolism—the oxidation of proteids was less perfect, and a larger quantity of uric acid was formed than in health.

Much labor has been spent in calculating the normal proportion of uric acid as to urea in the urine; this has been established by Haig as 1 to 33. According to this author, every departure from this proportion is pathological.

The old theory of the pathogenesis

of gout contended that, when retardation of metabolism took place, much more uric acid than normally was formed; the uric acid accumulated in the blood, and when the blood had thus been loaded with the compounds of uric acid it deposited them in the articulations, etc.

This theory has been overthrown by recent investigations. Kossel, Horbaczewski, and many other investigators have shown that uric acid is not a product of the metabolism of the proteids, but that it is formed by the oxidation of nuclein—an albuminous compound which differs from the proteids in that it contains a greater proportion of phosphorus. The nuclein is contained in the nuclei of cells, and may be prepared from all cellular structures, such as the spleen, the thymus gland, etc.

Various functional tests in 5 gouty patients with tophi as well as in 2 non-gouty patients, showed that in all the gout cases there was definite depression of renal function. A considerable increase in both the non-protein and urea nitrogens in the blood was observed in all but 1 case, and the 2-hour renal test gave clear evidence of disturbed function in 4 cases, with suggestive evidence in another. Many of the findings heretofore considered due to disturbed nuclein metabolism in gout may be explained as results of renal inadequacy, *e.g.*, the faulty elimination of exogenous uric acid and of other nitrogenous substances. The prevailing theories as to the etiology of gout remain hypotheses without satisfactory experimental bases. McClure (*Arch. of Internal Med.*, Nov., 1917).

Schittenhelm, furthermore, has shown the presence of a special tissue oxidase in the kidneys and muscles whose function is to oxidize and destroy the uric acid.

It has further been demonstrated by many experiments that the excretion of uric acid in the urine is increased or diminished by all factors (diseases, medicines, poisons, etc.) which give rise to a more rapid or slower disintegration of the cellular elements of the body and especially of the leucocytes. The ingestion of food causes a temporary leucocytosis (digestive) followed by an increase of the formation and excretion of uric acid. The amount of uric acid excreted in twenty-four hours is not much influenced by the nature of the food (animal or vegetable); there is, however, this distinction noticeable: that the more easily digestible animal proteids set up digestive leucocytosis and formation of uric acid much quicker than the vegetable albumins, which are difficult to digest.

While it is easy to increase the quantity of urea excreted in twenty-four hours by the ingestion of large quantities of proteids, the excretion of uric acid is not much influenced in that way. Weintraub, Umber, and Kühne have demonstrated that the excretion of uric acid may be increased to 2 or 2.5 Gm. in twenty-four hours by giving large quantities of nuclein,—for instance, 500 Gm. of the thymus gland,—whereas the normal excretion of uric acid varies from 0.4 to 1 Gm. per day.

The augmented formation of uric acid will, of course, lead to a temporary uricemia, which usually does not cause any morbid symptoms, but is only characterized by an extraordinary increase of the excretion of uric acid compounds in the urine.

By chemical investigation of the gouty deposits, these have been found to consist of an acid compound

of uric acid with sodium; the so-called sodium biurate or monosodium urate.

In serum rich in sodium salts the biurate crystals are more easily separated than usual; irrespective of the acid with which they are combined, the salts of calcium, magnesium or lithium, or piperazin, do not affect the rapidity and the degree of deposition, whereas all salts of potassium delay the deposition of crystals of biurate from blood-serum.

The local blood-supply of tissues the seat of acute gout is reduced. This results in increased hydrogen ion concentration, greatly favoring autolysis, which ensues chiefly if not wholly in asphyxiated tissues. The writer's view, then, is that from local ischemia the cartilage undergoes anemic necrosis, with secondary uratic deposition in the connective tissue replacing it. Wells states that during autolysis the intracellular enzymes attack the protein group of the nucleoproteins, setting free the nucleic acids. These, in turn, are disrupted by the specific enzyme nuclease, liberating the purin bases, which undergo further disruption. The uratic deposits may, plausibly, be due to inadequate removal of the substances resulting from these local nuclear activities, the high sodium content of cartilage determining the uratic deposits in it. R. L. J. Llewellyn (*N. Y. Med. Jour.*, Nov. 21, 1923).

The researches of von Jaksch have shown that in various diseases the blood contains an abnormal quantity of uric acid, and different authors have proved this to be the constant result of an increased disintegration of leucocytes. A physiological leucocytosis has been observed in the first days of life, amounting to the double or triple, followed in the fifth day by a sudden fall of the number of leucocytes almost to the normal; this is

accompanied by an excessive formation and excretion of uric acid, giving rise almost constantly to the excretion of uric acid sand and frequently to the formation of uric acid infarctus in the kidneys (Gundobin, Fleusburg). Bartels, Laache, Ebstein, and various other investigators found an extraordinary increase of the daily excretion of uric acid in leukemia; von Jaksch, Laehr, and Ewing observed a hyperproduction of uric acid and leucocytosis in pneumonia, and similar results have been found in the first stage of carcinomatous and all other diseases accompanied by leucocytosis. In all these maladies the hyperproduction of uric acid is distinguished only by the increase of the excretion of this compound, but the existing uricemia is not conducive to gout or any of the symptoms of this complaint. The pathogenesis of gout is consequently not dependent on uricemia alone, and it is necessary to examine the special conditions under which uricemia may be attended with gout.

Various theories have been proposed in this connection. The best supported of them will now be briefly discussed.

According to Garrod, gout depends on a temporary or continuous decrease in the ability of the kidneys to excrete uric acid, by which an overcharging of the blood with uric acid is caused. Gout, in his opinion, is never caused by hyperproduction of uric acid, but by retention of it, although the progress of the disease is accelerated by temporary hyperproductions.

Garrod found a distinct diminution of the percentage of uric acid in the urine as well in chronic gout as in



the acute cases, except during the attacks, when more uric acid than commonly was excreted; he, therefore, regarded the gouty attack as a salutary process which tends to deliver the system of its surplus of uric acid. Unfortunately the analytical methods used by Garrod (Heintze's method and the thread method) were not reliable enough to prove the correctness of his statements.

Haig accounted for certain manifestations of gout on the basis of changes in the reaction of the blood. The blood, he stated, normally holds a certain quantity of uric acid in solution. If excessively alkaline, it will hold in solution an abnormal quantity of uric acid. Then some exciting cause, such as cold, acid diet, malt liquors or acid fermentations in the stomach results in a sudden acidity of the blood and consequent precipitation of uric acid in the tissues.

Gout represents inability of the liver to deal adequately with uric acid, the latter settling in the joints by a vicarious mode of elimination. Mineral waters mobilize the uric acid, which passes back into the blood and is eliminated with the urine. The presence of uric acid in excess renders the colloidal balance of the blood serum precarious. Any slight cause such as chilling, dietetic error or trauma is liable to disturb this unstable balance and sensitize the gouty patient so that an exciting cause, such as heavy wine, will produce an upset, an acute attack following. Chauffard (*Presse méd.*, Mar. 25, 1922).

More recently the influence of toxic infections in the intestinal tract or elsewhere on the production of gout has been emphasized. According to Llewellyn, most cases have local foci

of infection. Along with this condition there is present an inherent abnormality or instability of nuclein metabolism, together with an increased tissue affinity or retention capacity for uric acid. These tissue peculiarities are caused by the infections to become manifest as gout, the micro-organisms exciting an inflammatory reaction followed by uratic deposition, articular or abarticular. The predilection of such uratic deposition for certain tissues is determined by their greater content of sodium ions as compared with the blood.

Bassler has expressed the view that the cause is a chronic excessive putrefaction in the intestine of the saccharobutyric form, in which the acute attacks come on from a sudden overloading of the general system with toxins from the intestine, although this intoxication is always more or less present in the intervals. In these acute attacks the power of the liver to oxidize the purin bases of the body from uric acid into urea is curtailed, and an output of uric acid salts instead of urea, is the result. The uric acid salts, being insoluble and difficult of elimination, accumulate and become deposited where the circulation is at its lowest ebb, viz., in the cartilages of the small joints and the fasciæ.—EDITORS.

Injecting uric acid into gouty and other patients, the writers noted poor excretion and a prolonged increase of the blood uric acid content in the gouty.

The disturbance of excretion is not the only factor, however, as urates in the great toe are not found in contracted kidney. They consider a uricemia of 4 mgm. per 100 c.c. of blood, coupled with low concentration of uric acid in the urine, as pathognomonic. Before making a diagnosis on this basis, however, exclusion of purins from the diet for 3 days is necessary. Tannhauser and Weinschenk (*Deut. Arch. f. klin. Med.*, Apr. 18, 1922).

Entertaining the view that gout is due to an infection, the writer points out that during an infection some cells are liable to succumb to the action of the virus, while others are less seriously affected. The nuclein derived from the first of these groups of cells he supposes to yield an abnormal, gelatinous uric acid, and that from the other group, normal, crystalline uric acid. The crystalline acid is gradually excreted by the kidneys, but the gelatinous is retained in the circulation for 3 or 4 days. This period of retention coincides with that which precedes or accompanies the onset of an attack of acute gout, when the renal excretion of uric acid is apt to be subnormal. The anions of the gelatinous acid, by virtue of their colloidal nature, form aggregates too large to pass through the kidney cells. Their aggregation is easily loosened, however, in the presence of a multiplicity of sodium kations such as exist in cartilage and other sodium-rich tissues. The capillaries of these tissues offer little resistance to the passage of the uric anions through them, and in the lymph the uric and sodium ions combine chemically, forming sodium biurate. This, in consequence of the high sodium concentration, is more or less precipitated. But as the act of precipitation, by the removal of sodium, lowers the sodium concentration, the precipitate undergoes partial solution, the dissolved part, after absorption, being carried to the kidneys for excretion, and the undissolved portion remaining, possibly to form the nucleus of a tophus, or to be absorbed later. It is the simultaneous elimination of this sodium biurate, coming from the gelatinous uric acid, with some of that of the crystalline acid, which makes the renal uric excretion abnormally high at the acme of a gouty paroxysm. The removal of sodium by precipitation renders the other kations in the lymph, thereby unbalanced, toxic, with a resulting local pathologic reaction in the form of Ebstein's necrosis or a milder inflammation. W. J. S. Jerome (Proc. Roy. Soc. of Med., Aug., 1925).

Although in the light of all the theories on the pathogenesis of gout discussed above and of the observations of innumerable investigators, many questions regarding the real nature of this complaint are still left unanswered, some facts are nevertheless settled beyond all doubt.

It is proved that in various diseases the blood contains an excess of uric acid and that gout is one of these diseases; secondly, it is certain that an excess of uric acid does not cause the deposit of biurate as long as the kidneys are healthy and their action normal.

In all described cases of gout in which the post-mortem examination is mentioned the kidneys have been found diseased, and in almost all cases they were the seat of granular atrophy. Ebstein reported 2 clinical cases of gout in which the kidneys had been found healthy, but close investigation revealed the fact that the cases were so incompletely described as to be utterly valueless in that respect.

In all cases of granular atrophy of the kidneys, the power of elimination of the kidneys as regards uric acid, as well as various other substances, is diminished. Charcot found it defective under the administration of turpentine, which does not give the urine the characteristic odor of violets when the kidneys are granular atrophic. The consequence of this defective elimination of uric acid is its retention in the blood (von Jaksch), and various observers (Ord and Greenfield, Norman-Moore, Levison, Luff) have demonstrated that in granular atrophy of the kidneys deposits of biurate in the joints are very frequently found, even when no

symptom of gout has been manifest during life.

Lead poisoning resembles gout in giving rise to an excess of uric acid in the blood, although it is not accompanied by leucocytes or increased disintegration of whole blood-corpuscles. Now, it appears from experiments on animals (Charcot, Binet, Coen, and d'Ajutolo), as well as from observations of persons exposed to lead poisoning, that one of the earliest and most constant symptoms of this disease is a pathological change of the renal tubuli conducive in rather short time to granular atrophy of the kidneys. This accords very well with the fact that lead poisoning is very liable to give rise to gout, and that Garrod, Lancereaux, and various other observers have found that a large percentage of their gouty patients suffered also from the consequences of lead poisoning.

It has been proved by many experiments that continued irritation of the kidneys by chemical or mechanical irritants leads to inflammatory processes and formation of new connective tissue, resulting in granular atrophy. When the kidneys of patients suffering from gravel and calculi for some time are examined granular atrophy is always found.

When gouty persons are attacked by an intercurrent disease causing a temporary hyperproduction of uric acid,—as, for instance, pneumonia,—they are sure to get an attack of acute gout in connection with it.

When all these facts are combined and confronted they seem without exception to point to a theory of gout closely allied to the views proposed by Garrod.

Gout and its principal symptom—

the deposition of biurates—occur when the blood remains for some time overcharged with uric acid which cannot be eliminated by the kidneys on account of a decrease of their secretory power, which, in turn, is caused (with very few exceptions) by granular atrophy more or less distinctly developed. In all cases of gout the kidneys are diseased, and the gout can never develop as long as the kidneys remain healthy. The morbid state of the kidneys may either be due to inherited predisposition (gout in children, early gout hereditary in families) or be acquired by chronic irritation (lead poisoning, abuse of alcoholic stimulants, uric acid gravel and calculi). As long as the deposition of biurates progresses very slowly no symptom whatever is caused by it, and it is even possible that the deposits may be redissolved without having caused pain or injury at all; but when the deposits grow too large or when from any cause (excesses of every kind, intercurrent diseases, etc.) the production of uric acid gets very large, the deposits increase quickly, the lymphatics are obstructed, and a genuine attack of acute gout is produced. Injudicious therapeutics, such as the abuse of alkaline remedies or springs, are liable to produce attacks of gout by the ingestion of large quantities of sodium salts, which have a distinct deterrent influence on the solution of the quadriurates in the blood.

This theory does not explain all the various and anomalous symptoms of gout, and the question is left unanswered as to why all patients suffering from granular atrophy of the kidneys are not attacked by gout; but it has the advantage that it brings

into one category all the etiological and pathogenic factors with which we are acquainted, and gives a plausible explanation of the origin of gout as well of the rich and overfed classes as of the poor and badly nourished. By this theory the close alliance of uric acid gravel with gout becomes intelligible, and the enigmatic gout caused by lead impregnation has a rational explanation.

**PATHOLOGY.**—The most characteristic pathological change found in gout is the presence of deposits of sodium biurate in various tissues. The order of invasion is fairly constant: the diarthrosial cartilages are the first to be affected; then the ligaments, tendons, and bursæ; next the connective tissue and the skin become impregnated. Of the articulations the metatarsophalangeal joint of the great toe is generally first affected, then the different metatarso- and metacarpo- phalangeal articulations, the tarsus and carpus, and next the larger joints; but their order is not constant. Almost all joints are attacked by gout,—perhaps with the exception of the hip-joint. The deposit first occurs in the superficial part of the cartilage close under its surface, in the form of fine, crystalline needles forming a more or less close network and presenting different degrees of opacity; sometimes it may be so small as to require the aid of a microscope for its detection. At first the central parts of the cartilages only are impregnated, whereas the peripheral tissues are free from deposits, but present some vascularization. Subsequently the fibrocartilages, ligaments, and synovial membranes become involved with white chalk-line deposits consisting

of sodium biurate; the synovial fluid may also contain crystal needles. The articulations become stiffened or fixed and ultimately they are greatly distorted and nodulated. The skin covering the affected joint becomes distended, and it may even be destroyed, exposing chalky masses, which break down and are successively evacuated, frequently giving rise to suppurative and ulcerative processes of the skin. It does not mean that the deposit is specially infiltrated in the cells, but rather that it pushes its way without special regard as to the component elements of the cartilage.

Recent research has demonstrated that uric acid can be found in the blood in normal conditions, even on a diet free from purins. The mere discovery of uric acid in the blood on a purin-free diet does not necessarily mean gout. The proportion is much larger in those inclined to gout. This accumulation of uric acid is not due to simple exaggeration of the production of uric acid; when this occurs there is always a larger uric acid output in the urine. In gout the urine does not contain an abnormal proportion of uric acid and it seems as if the endogenous production of uric acid was rather below normal than above. The trouble seems to be retention, and the question is why the abnormally large proportion of uric acid in the blood is not passed out through the kidneys. The kidneys seem to become impermeable for uric acid alone: gout is not uremia.

The assumption seems permissible that either the uric acid itself has become modified in its physical or chemical properties, or else certain metabolic processes which govern the fate of the uric acid have become modified—the trouble does not seem to be in the kidneys themselves. O. Minkowski (Med. Klinik, May 18, 1913).

The periosteum and bursæ may also be implicated, and some authors have even believed that the bone itself may become affected. Virchow drew attention to isolated infiltrations of biurates in the spongy tissue of the phalanges, and in the marrow of the bones deposits may occur—mostly, but not always, in the neighborhood of incrustated cartilages.

Marchand and Lehmann have made chemical analyses of bone-tissue of gouty patients, and found that when the cartilages and the periosteum were removed the osseous tissue itself did not contain uric acid. Garrod observed that in gout of long standing the osseous tissue of the phalanges may become rarefied and the vacuoles filled with fat; by this process the bones are rendered more fragile than in the normal state.

Contrary to what has been observed in healthy subjects, uric acid in gouty patients has a tendency to deposit in the tissues in the forms of crystals of sodium acid urate. These deposits can be found in all the tissues, but predominate in the connective and particularly in the cartilaginous tissues.

The blood cholesterol is increased in gout and cholesterol is present in tophi. It is situated in the center of the tophus, while sodium urate is at the periphery. A fibrocellular and giant cell reaction surrounds these substances. The central position of the cholesterol is similar to that in gall-stones and aortic atheroma. One of the writers always found in hypercholesterolemia a tendency to the formation of deposits of the substance. Articular tophi, however, are neither a constant lesion in gout nor its exclusive manifestation. Chauffard and M. Wolf (*Presse méd.*, Dec. 5, 1923).

Brugsch and Schittenhelm have explained the process as follows: (1)

Cleavage of the nucleoproteids normally takes place until it reaches the stage of purin bases. One finds, for example, in the urine of the gouty to whom 10 Gm. ( $2\frac{1}{2}$  drams) of thy-monucleinate of soda is injected, that all the nitrogen exists as purin bases, uric acid, and analogous substances reduced to the lowest point of degradation. (2) The transformation of purin bases into uric acid is retarded. In gouty patients a part of the nucleinate of sodium is eliminated as purin, without having reached the stage of uric acid. (3) The destruction of the uric acid is lessened, and on this account it accumulates in the blood.

Levene and Kristeller have found reason to agree with the conclusions of Brugsch and Schittenhelm concerning nuclein metabolism, but have emphasized also the deficiency of elimination in gout, observing that the excretion of nitrogenous substances is sluggish, while the oxidation of even as simple a substance as asparagin is abnormally slow.

In studies on the variations of the blood uric acid in gout, the writer found that in the fasting state the uric acid in the serum is considerably higher in gout than normally, so that readings up to 0.05, 0.06, 0.08 and even 0.12 Gm. per 100 c.c. of serum are obtained, as against the normal 0.01 to 0.03. After meals an increase occurs which is more pronounced and, especially, more prolonged in the gouty than in normal subjects.

The acute gouty attack is a phenomenon of absorption and not of formation of gouty deposits. The blood uric acid does not begin to change until the second or even the third day after the onset, when it may increase to a level  $\frac{1}{4}$  or  $\frac{1}{2}$  above the amount originally present. This increase persists for a time after the subsidence of the attack. Gouty serum shows low-

ered alkalinity as compared to the norm; expressed in c.c. of decinormal soda solution, with phenolphthalein as indicator, the range of alkalinity in normal subjects was found to be from 1.7 to 2.4, and in the gouty, from 0.9 to 1.8. Lowered serum alkalinity is not encountered in the uricemia of nephritis. In all instances the writer found the alkalinity increased at the beginning of the acute gouty attack. Serum collected during the acute stage can still dissolve uric acid; this invalidates the view that the blood becomes saturated with uric acid when the attack begins. Upon subsidence of the attack the serum alkalinity continues raised for a time above the pre-existing level. Uricemia increases and decreases with the serum alkalinity, though not in a direct ratio to it. Repeated ingestion of alkalies increases the uricemia, and the alkalies must, therefore, be considered as favoring the onset of acute attacks. Joulie's phosphoric acid treatment produces the opposite effect; patients taking this remedy for some time reported a reduced frequency of attacks, while some noticed increased size of their tophi. In such patients the blood uric acid was the same as in other gouty cases, though the alkalinity seemed diminished. Excretion of uric acid increases more or less during an attack; where this increase is not pronounced, a considerable increase of urea excretion takes place. The increasing size of joint tophi after successive attacks is due to the local inflammatory reactions which determine the rapid resorption of gouty deposits. The tophi contain much more of calcium carbonate and phosphate than of uric acid; it is the lesions due to osteitis which bring about the formation of tophi. Study of the oculocardiac reflex showed that gouty subjects are sympathicotonic. Charles Finck (N. Y. Med. Jour., Dec. 19, 1923).

The popular idea that the urine is loaded with uric acid in gout is unfounded; in fact, there is a diminished excretion as compared with that in normal individuals. The writer at-

tempted to produce sodium urate deposits by injecting uric acid in large doses intravenously in the joints of rabbits which had previously received injections of organisms from acute rheumatic cases. Some rabbits developed typical rheumatic joints, but no sodium urate deposits. The experiments were repeated on rabbits with uricemia nephritis, with equally poor results. The factors predisposing to gout lie beyond the mere metabolism of uric acid. D. R. Black (Jour. Mo. State Med. Assoc., Sept. 1924).

Heberden observed a nodular or bosselated condition of the terminal phalangeal joints; this pathological state of the fingers has been known as Heberden's finger. In Heberden's opinion, the nodes are not of gouty origin, but caused by arthritis deformans; a similar formation of the phalanges may, however, also be observed in very old gouty patients.

Deposits may be found in various other parts of the body, such as the external ear, eyelid, nose, and larynx; they form there nodules—tophi—which at first contain a liquid, but after some time get hard. Garrod evacuated from a single tophus of the hand 60 Gm. (2 ounces) of sodium biurate.

The muscles of gouty patients are ordinarily atrophic, especially when the extremities get stiffened and immovable.

The heart is frequently hypertrophic; myocarditis may occur, leading to the formation of fibroid or fatty degeneration of the muscles. The endocardium is sometimes in a state of chronic inflammation, and uratic deposits have been observed in it. In the aorta arteriosclerotic changes and uratic deposits have been noticed.

In the digestive tract congestion and a catarrhal state are found, as

well as ulceration of the mucous membrane; but as the ulcerations are observed only when the granular atrophy of the kidneys is fairly developed, they are probably caused by the renal disease and cannot be regarded as directly gouty.

Gout of the intestines is essentially a catarrhal process which affects primarily the mucous lining of the entire alimentary canal, and may be limited to it or involve the neighboring fibrous tissues. It follows the usual course of catarrhal inflammation, beginning with congestion and marked by mucous, mucopurulent, or purulent exudation, being more amenable to treatment in the early stages. If unchecked it produces ulceration, increase of connective tissue, adhesions, and distortion of structure, more rarely to definite and visible deposit of biurates in bulk, and not uncommonly to an interstitial accumulation. Parts exposed to cold, acids, heat, or irritant substances are first affected, and it may spread by fibrous tissue continuity or by microbic invasion along with urate precipitation and impaired circulation and metabolism. The chronic irritation produced in the tissues paves the way for cancer, which affects chiefly the parts exposed to cold, acids, heat, and irritants. The warmer parts having a large supply of alkaline blood or secretions are avoided by catarrh and cancer alike, while the acid parts, stomach and rectum, are favorite seats. The relation of these intestinal troubles to gout and rheumatism is constant, and like bronchial and other respiratory catarrhs they are all made worse by acids, cold, and retentives, and better by alkalies, heat, and uric acid solvents, thus aiding diagnosis. Haig (*Med. Rec.*, Oct. 12, 1912).

The liver is commonly enlarged and in a state of fatty infiltration or of interstitial hepatitis; when this is the case, the spleen may also be enlarged.

The kidneys are always more or less pathological. In the large majority of cases they are granular-atrophic: the kidney is contracted with a rough and granulated surface, small cysts are commonly seen on it, the capsule is adherent in different places, the color of the organ is red, the cortical substance warty and granular, and the walls of the arteries generally thickened; in short, the gouty kidney is identical with the small, granular kidney. In some cases deposits of biurate are found in the tubuli or between them, appearing as whitish points or lines in the red structure of the organ. Uratic deposits may also be found in the pelvis and in the bladder.

A few observers have noticed the presence of sodium urate deposits in the meninges of the brain and in the neurilemma of peripheral nerves.

**PROGNOSIS.**—Acute gout is rarely immediately fatal; the attacks are very liable to return, but much depends on the mode of living adopted by the patients. Chronic gout decidedly shortens the life of the patients and often results in crippling them completely. The kidneys are always diseased in gout, and, when the granular atrophy of the kidneys develops to its utmost, there may be serious danger from the retention of the constituents of the urine, and gouty patients may die from uremia.

Gout diminishes the power of resistance against acute disease and injuries; many gouty patients, nevertheless, reach an advanced age.

**TREATMENT.**—Prophylactic treatment of gout is of the greatest importance not only to prevent the first attack in the case of hereditary

disposition, but also after the first attack to prevent or at least delay recurrences.

**Dietetic Treatment.**—Gouty patients should avoid all aliments containing nucleoproteids, which, necessarily, tend to increase the percentage of uric acid in the blood; hence are contraindicated all glands and internal organs composed chiefly of cells, such as brain, kidney, sweetbreads, liver, and especially thymus gland; also meat-extracts contain much nuclein and are not to be allowed. Eggs do not contain nuclein, but paranuclein, which in the body is not decomposed into uric acid, and moderate quantities of eggs, therefore, can be eaten by the patients.

The first point of attack in the rational treatment of gout is the uric acid circulating in the blood, *i.e.*, the uricemia. Just as it is necessary in diabetes to keep the patient on a non-sugar-yielding diet for several months or even years, it is necessary to prevent a gouty patient from eating purin-yielding food. By prolonged care in the diet most cases of uricemia not complicated by diseased kidneys can be cured. Some of the uric acid in the blood comes from the breaking down, within the body, of white blood-cells and other nuclein-containing tissues, but the purin-free diet must reduce the uric acid salts in the blood. Meats and flesh of all kinds, even fish, contain purin bases and to prevent uric acid from being formed from the diet, flesh of all kinds must be prohibited. It has long been known that foods that are rich in purins, such as liver, pancreas, thymus, brain, or other sweetbread tidbits, shad roe or of other fish, should be excluded from the diet of a gouty patient. Alcohol in any form taken with an ordinary meat meal increases, probably by its action on the liver, the formation of uric acid. Consequently, alcohol in

any form should not be allowed to patients with a meal which contains meat, even if alcohol is allowed between meals, or with other foods. Schittenhelm (*Therap. Monats.*, Bd. xxiv, Nu. 3, S. 113, 1910).

Boiled meat contains less purin bodies than roast, but fish does not differ materially from meat in general in this respect. Small fish contain more purins than beef and pork. (O. Minkowski (*Med. Klinik*, May 18, 1913).

On a number of occasions the writer has been promptly relieved, without medication, by a rice diet for a number of days, and has also used it successfully in other cases.

The diet consists of rice, butter, bread and water exclusively, 3 times daily for from 5 to 7 days. The rice should be eaten hot, with butter and not with sugar and milk, for half an hour or more at each meal, with thorough mastication. He gives  $\frac{1}{2}$  pint of water, not iced, with each meal, but not when food is in the mouth, and also  $\frac{1}{2}$  pint of hot water, an hour before the morning and evening meal. Bulkley (*N. Y. State Jour. of Med.*; *Amer. Med.*, Apr., 1917).

As the proteids do not change into uric acid, there is no reason to prohibit meat or fish in moderate quantity; about 200 Gm. ( $6\frac{1}{2}$  ounces) daily is quite sufficient, and a larger quantity will only tax the digestion and the secretory power of the kidneys.

All sorts of farinaceous aliments, bread, milk, cheese, fruits (when they do not disagree), and vegetables of every kind, are to be allowed.

Chemical study of the metabolism of 137 cases of gout. The elimination of uric acid, according to the writer, follows typical curves. The amount of endogenous uric acid grows less and less until the onset of an acute attack of gout, when there is a rise in the curve. This rise attains its maximum height two



or three days after the onset of the acute attack. Then there is a gradual falling off in the uric acid elimination to amounts below the normal during the intervals between the attacks. When an acute attack is impending no meat should be allowed. It is still further advisable to arrange several purin fast days in each week, and thus give the body the opportunity to eliminate its excess of uric acid. This regimen must be kept up for months and years in order to avoid the later severe stages of this disorder. **Drinking large amounts of water** aids in the excretion of uric acid, but, contrary to the long-accepted opinions, alkaline waters have the opposite effect. None of the alkaline or mineral waters has any specific effect upon gout, and this is especially true of the lithia waters. Umber (*Therap. d. Gegenwart*, Bd. ii. S. 73, 1909).

With purin reduction by means of a **meat-free diet**, there should not be associated an excess of fats and carbohydrates, as such would tend to reduce uric acid excretion. Laxative doses of **magnesium sulphate** and **sodium bicarbonate** increase uric acid elimination. Small doses of **radio-active substances** exert a striking influence in gout. Gudzent (*Berl. klin. Woch.*, Nov. 28, 1921).

Some gouty patients appear hypersensitive to beef, others to pork or veal, some to shell fish, others to certain vegetables or fruit, *e.g.*, strawberries. The almost fulminant response in some instances suggests that the gouty outbreak is due to absorption of unaltered protein. The food idiosyncrasies do not relate exclusively to nuclein-rich foods; some patients can take sweetbreads with impunity. The idiosyncrasies are due to protein sensitization, and the disturbances in nuclear metabolism are secondary thereto. Llewellyn (*N. Y. Med. Jour.*, Nov. 21, 1923).

Peas, beans, and lentils, however, yielding a fairly large amount of purins, should preferably be used

only in moderation. Limitation is in order as regards soups made from meat stock, which are rich in purins.

Highly seasoned dishes are to be avoided, including salted foods, as well as such articles as pickles and vinegar, the object being to spare the kidneys and obviate the tendency to disturbance of gastric digestion attending the use of these articles.

According to some, a general reduction of caloric intake, rather than a special restriction of purin-yielding foods, is the chief desideratum. Certain it is that many gouty subjects are addicted to excessive consumption of food. Reduction of cholesterin and of chlorides has also been advocated. Where a patient submits only with difficulty to continued restrictions, Martinet has found it politic and advantageous to insist on restriction to a vegetable diet, a milk diet, or a fruit diet on two days in every week.

Guelpa's detoxication treatment, also used in diabetes, combines **fasting** for varying periods, not generally exceeding 3 days, with the use of 40 Gm. (1½ ounces) of **sodium sulphate** each morning of the fast. At the termination of the first fast, a very restricted diet is taken, the normal diet with meat being resumed only after 8 or 10 days. Guelpa insists on the copious watery purgation, repeated at intervals, if proper results are to be obtained. Sir Henry Lunn (*Lancet*, Dec. 3, 1921).

A purin-free diet acts very well in many cases of gout. However, there are patients who cannot bear this diet long. Fish and some shellfish, if eaten fresh, are harmless. The writer allows ordinary bread, plain or toasted, or plain biscuits. He believes that plainly cooked potatoes are entirely harmless. Green vegetables, especially spinach, cress, and lettuce, are of value. **Asparagus**

should be given very sparingly. Fruits, both cooked and raw, may be given to gouty patients. Tea, coffee, and cocoa have no bad effects, with the exception of strong black coffee taken after meals, which he prohibits. A single wine in small quantity, preferably port, Bordeaux, or champagne, is allowed. The writer deprecates large mixed meals of animal and farinaceous food elaborately prepared and richly seasoned. He forbids cooked tomatoes, rhubarb, and food cooked with fat or sugar. Sauces, relishes, and highly spiced food must be avoided. Both lemon juice and vinegar are harmful. Mustard and salt may be taken in moderation. **Abundant water** should be given to gouty patients, and should contain little calcium or iron. The continued use of alkaline or lithia drinks often is harmful and should be forbidden. Duckworth (Pract., Jan., 1909).

Fats are to be allowed in quantities that will not produce acidosis. The amount of food, moreover, should not be excessive, and regular movements of the bowels must be insisted on (salines).

It is useful to prescribe rather large quantities of inoffensive beverages, such as pure water and milk, especially skimmed milk or buttermilk, to favor the free action of the kidneys. Tea and coffee are allowed, in moderate amounts, and also light, dry cider.

Eight cases of gout in which the beneficial effect of **cider**, when substituted for wine as an exclusive beverage, was clearly shown. The acute attacks either ceased entirely or became much less frequent, even, in 3 instances, where tophi were already present. Where wine (Bordeaux or Burgundy) was resumed, and cider discontinued, an attack soon took place. In several patients in whom restriction to mineral waters had yielded but slight benefit, cider

proved far more efficacious. Motais (Bull. de l'Acad. de Méd., July 2, 1912).

The quantity of urine per twenty-four hours ought to be about 1500 to 2000 Gm. (3 to 4 pints). Alkaline springs have been much recommended, but not on very solid grounds. Their use should not be exaggerated, as the ingestion of much soda in the blood is liable to accelerate the deposition of biurate, and thus provoke an attack of gout.

**Open-air exercise** is very useful in the treatment of gout, and, when possible, gouty patients ought to spend their holidays in regular active exercise, such as walking, cycling, riding, etc.

**Treatment of Hereditary Gout.**—Much can be done in these cases by the use of proper dietetic and hygienic measures. The children of gouty parents should be taught early the relation between food and **exercise**. They should go hand in hand; any increase in food demands additional exercise, and when exercise is not available the diet should be low. Proper clothing should be provided to protect from the effects of changes in temperature, and draughts should be avoided. Malt liquors and sweet wines should be interdicted, and milk and eggs should be used rather than meats and pastry.

With respect to those persons who are goutily disposed by inheritance in any degree, the treatment may be said to consist mainly of an appropriate nutrition with some restriction of animal food and a limited amount of saccharine matters, especially of food cooked with sugar and fatty materials. Meals consisting of animal food and carbohydrates, with sugar, taken at one time, are found to be imperfectly digested by such

persons. An **open-air** life, especially in inland and somewhat elevated districts, is desirable. Water much impregnated with lime is improper. Marine districts, especially in exposed situations, are apt to be unfavorable for most of these subjects. Occasional **aperients**, containing some mercurial, are of especial value. In cases of an asthenic type, especially in young girls with feeble circulation and tendency to chilblains, it may be desirable to employ a small quantity of some **red wine**,—Bordeaux or Burgundy,—well diluted with water, with the principal meal of the day. Exposure to cold and damp is especially to be avoided. Maylard (Lancet, May 6, 1911).

#### **Treatment of the Acute Attack.**—

Abortive treatment of an acute attack of gout has repeatedly been tried, but it is not to be recommended, being attended with the great risk of inducing an attack of internal gout. The method proposed has been strapping the affected joint with adhesive plaster; the application of snow or ice; the hypodermic injection of morphine; large doses of colchicum, etc. Undoubtedly the attack may be stopped short by these methods, but very dangerous symptoms, such as fainting, disorder of the action of the heart, etc., have been observed as the immediate result of these procedures.

Although medicine has now abandoned the old maxim that during the attack the affected joint was only to be treated "with flannel and patience," the treatment of the attack ought not to be too active. The patient should remain in a recumbent position, though not necessarily in bed, for some days; the affected limb should be raised and supported, kept warm, and protected from pressure. The pain is relieved by **warm alcoholic lotions**, application of **opium oint-**

**ments**, **liniments**, or **menthol** in an alcoholic solution. **Ointments of ichthyol** are also to be recommended.

Most of the remedies are useful, mainly through the suggestion of relief they afford to sufferers. Blood-letting and blisters were formerly in use, but are now generally abandoned, as they have a tendency to give rise to internal gout.

English practitioners often begin the treatment of an attack of gout by the administration of a free purgative: **calomel** and **jalap** or **mistura sennæ composita**.

Of remedies directed toward the gouty process itself **colchicum** is the most effective; its mode of action has been solved by modern study and investigation. Rutherford has demonstrated its great cholagogue powers, and, as the liver has largely to do with uric acid formation, the mode of its action is apparent, and also why it produces its sedative and anesthetic effect without necessarily causing purgation or vomiting; in fact, these latter effects are to be avoided, and, if purgation is thought desirable, it is better to add some aperient to the colchicum. But it seems to relieve the pain better than any drug; colchicum is ordinarily prescribed as wine of colchicum and may well be combined with tincture of **aconite**; 25 minims (1.5 c.c.) of wine of colchicum with 3 to 5 minims (0.18 to 0.3 c.c.) of tincture of aconite may be given three or four times daily. The use of colchicum ought only to be continued from four to six days, as it is liable to produce nausea and diarrhea, and even paralysis of the nervous centers when taken too long a time. An alkaloid of colchicum—**colchicine**—is employed in doses of  $\frac{1}{120}$  to  $\frac{1}{80}$

grain (0.0005 to 0.002 Gm.) two or three times daily. The salicylated colchicine of Merck, a yellow powder, may be given in the dose of  $\frac{1}{80}$  grain (0.0008 Gm.) four times daily. As soon as the anodyne effect of colchicum has been reached the use of the drug is to be discontinued. Under any circumstances, however, it should no longer be given when nausea or diarrhea sets in.

The acetic extract is the most effective preparation of colchicum. Following combination recommended:

*R. Pulv. opii,*

*Pulv. ipecac.* .ãã gr. j (0.065 Gm.).

*Pulv. cambog.* .. gr. ij (0.13 Gm.).

*Pulv. aloes* .... gr. iv (0.26 Gm.).

*Ext. colchici acet.* gr. viij (0.52 Gm.).

M. et ft. in pil. No. iv. Mitte xii vel xxiv.

Sig.: One pill 3 times a day, or 2 at night and 1 in the morning.

Matthews (Brit. Med. Jour., Aug. 30, 1919).

If taken at the beginning of the attack **colchicum**, besides bringing immediate relief, instantly stops the increase of hyperuricemia usually noticed at the onset of an attack; but it only slightly modifies the alkalinity of the serum. That colchicum arrests an attack by stopping the increase of hyperuricemia proves that gouty attacks are accompanied, not by a precipitation, but by a reabsorption of uric acid. A form of **autoserotherapy** is also recommended by the writer. As soon as the first symptoms appear, a blistering agent, calculated to yield about 5 c.c. (80 minims) of fluid, is applied. The fluid is collected aseptically with a needle and syringe and injected subcutaneously. By this procedure an attack can often be arrested. Tests show that the measure results in a drop of the blood uric acid, which had risen at the onset. C. Finck (N. Y. Med. Jour., Dec. 19, 1923).

**Sodium salicylate** was considered by Tyson much superior to colchi-

cum, although not so rapid in its effect. He advised 15 grains (1 Gm.) to be given four times a day, or 10 grains (0.65 Gm.) every two hours. Even larger doses may be given if well borne by the stomach. When the symptoms improve, the dose is lessened, but the drug must be continued for some time. Sodium salicylate acts best during the period of decline of the attack. Preferably it should be used only where the heart-muscle and renal function are good and excessive nervous irritability is not in evidence. **Lithium salicylate** has also been recommended.

It is difficult to enforce a very rigid régime on a gouty subject; he should, however, eat only 1 part of animal food to 3 parts of vegetable. He should be moderate as to sleep and take no after-dinner siesta. As to meat, beef, mutton, and fowl, not the meat of young animals. Of the vegetables, oatmeal, beans, peas, mushrooms, asparagus are taboo. Sugar, butter, fats, bread may be taken in moderation. Spiced food should be avoided. Only 2 eggs daily are permissible. **Sodium arsenate** is sometimes useful, and should be taken for four days at a time, followed by four days' suspension for a month. After this month the following may be tried:—

*R. Sodium phosphate,*

*Sodium benzoate,*

of each ..... gr. cl (10 Gm.).

*Distilled water* .. 3x (300 c.c.).

M. et ft. mist. Sig.: Tablespoonful before breakfast and dinner.

This prescription should be used for ten days. Then medication should cease and **mineral waters** be taken for a month.

In chronic gout more meat may be taken; **sodium salicylate** or **phosphate** may be given. Tophi may be treated by the **thermocautery** or **galvanocautery**. **Massage** is useful in helping general nutrition, stimulating

intestinal peristalsis, and combating muscular atrophy. **Vichy** is recommended for the florid overeaters, **Royat** for the weak. **Contrexéville** for those with arterial hypertension. The **chalybeate waters** sometimes cause painful attacks in the anemic, gouty patients, but act well, if cautiously given in certain dyspepsias and rundown conditions. Robin (*Bull. gén. de therap.*, March 23 and 30, 1911).

Attacks of gout are always accompanied by low blood viscosity (hydreemia). If mineral waters are prescribed in treatment, they will provoke an attack unless the blood viscosity is high. The treatment of an attack should aim to induce inspissation of the blood (**dry food**, **laxatives**). Laporte and Rouzaud (*Bull. Soc. méd. des hôp.*, Jan. 25, 1924).

When the pain has subsided and the swelling of the joint is somewhat diminished, gentle use of the joint and careful (but not energetic) **massage** are useful.

After the salicylates the alkaline carbonates have always held a high position in the treatment. Tyson gave  $\frac{1}{2}$  ounce (15 Gm.) of **potassium bicarbonate** a day in divided doses as the initial treatment, continued in smaller doses when the acute symptoms were relieved. A little lemon-juice improves the flavor. The **citrate of potassium** may be given in the same dose.

Sir William Roberts recommended  $\frac{1}{2}$  dram (2 Gm.) of **potassium bicarbonate** in a tumbler of water at bedtime for continuous treatment, to stem the nightly acid tide. Cohn has advocated systematic use of potassium salts to counteract an injurious influence of sodium, advising also abstention from sodium.

**Lithium carbonate** and **citrate** have been much used in doses of 5 grains

(0.3 Gm.), dissolved in a large glass of water, four times a day, but no special virtue on the part of lithium in gout is now recognized. These salts may, however, be useful as diuretics.

Numerous favorable reports have appeared on the effects of **cinchophen** (**atophan**) or **neocinchophen** (**nov-atophan**; **tolsyn**) in gout. The former compound, chemically phenyl-quinoline-carboxylic acid, is official as **cinchophenum**. These compounds have the property of greatly increasing the excretion of uric acid, which may be more than doubled, even with the patient on a purin-free diet. It is by no means certain, however, that it is through this action the drugs bring relief in acute gout. Their action is ascribed to a lowering of the renal threshold for uric acid. The blood uric acid shows a rapid fall, with a later return to the pre-existing level in spite of continued administration of the drug. That these remedies actually mobilize uric acid from the joints is very doubtful, though Feulgen has asserted that tophi are sometimes decreased in size. The drugs seem chiefly of value for the relief of joint pain and swelling, and may be given early in the acute attacks in doses of 15 grains (1 Gm.), well diluted, every 2 hours until relief occurs or the treatment is obviously ineffective. Partly to prevent precipitation of urates in the urine, simultaneous administration of **sodium bicarbonate** is advisable.

According to W. Denis, **benzoic acid** in doses of 75 grains to 2 drams (5 to 8 Gm.) a day increases uric acid excretion and lowers the blood uric acid. He has also pointed out that combined use of **acetylsalicylic acid**

and **sodium salicylate** in large doses will decrease the blood uric acid.

The writer used **atophan** in 48 cases—acute, neuritic, and chronic—with greater relief than had been obtained from other remedies, except in the chronic cases, in which effects were slight. Gouty sore throat and coryza also generally benefited. Dose, 30 to 60 grains (2 to 4 Gm.) a day, in 7½-grain (0.5 Gm.) tablets, 1 or, in severe cases, 2 after each meal and at bedtime, or every two or three hours. Kahlo (*Therap. Gaz.*, Dec., 1912).

Schmidt and Falkenstein have advocated the use of **hydrochloric acid** in continued high dosage, especially in cases with hypochlorhydria. The latter author himself took for over 5 years 50 to 60 drops a day of the concentrated acid, well diluted, with much relief from his gouty symptoms. From experience in 390 cases he claimed the treatment to be usually very effective in early cases; in more advanced cases it generally diminished the severity of the attacks and prevented further uratic deposits. Joulie and Martinet have advised instead the use of **phosphoric acid**. Martinet deems this remedy of definite service in long-standing cases that are atonic, debilitated and hypo-acid, and prescribes:

R. *Acidi phosphorici diluti* f3xiiiss (50 c.c.);  
*Sodii phosphatis acidi* 3v (20 Gm.);  
*Aqua destillata* ..... f3vss (160 c.c.).

M. Sig.: Three to six teaspoonfuls a day with the meals.

Martinet advocates determinations of the reaction of the body fluids as a criterion for preference of alkaline or of acid medication in the individual case.

Various basic organic products—**piperazin**, **lycetol**, **lysidi**n—were at one time recommended as specifics

for uric acid gravel and gout on account of their power to dissolve uric acid. Mendelsohn has tried the effects of all these compounds, and found that urine saturated with them does not dissolve uric acid any more than normal urine, and they are, of course, still more ineffective when circulating in feeble concentration with the blood.

Nevertheless, favorable effects have frequently been reported from **piperazin** in doses of 5 to 10 grains (0.3 to 0.6 Gm.), well diluted, 3 times a day. Fenner and others have lauded **thyminic acid** in doses of 4 grains (0.25 Gm.) after meals. According to Fenner, it should be given for 3 months, then every alternate week, to prevent onset of acute symptoms. He regards it as especially suitable for this purpose as well as for gradual improvement of symptoms in chronic or irregular gout.

Uricedin, a remedy proposed by Mendelsohn, is a combination of sodium citrate, sodium sulphate, and small quantities of sodium chloride and lithium citrate. It may be of use in the treatment of uric acid gravel, but in gout it is about on a level with the other compounds of sodium.

Lithium salts not only do not dissolve uratic concretions, but they upset the stomach very easily. In the gouty it is indispensable to keep the digestive functions at their best. Sodium salicylate, recommended by Fannel, thoroughly upsets the stomach, and, according to Luff, has not the least effect in dissolving gouty deposits. Lysidin is in no better repute. A possible exception, perhaps, is to be met with in **thyminic acid**—a product of the decomposition of the nucleins. When this is present it combines with uric acid and insures its solution, but when absent precipi-

tation of uric acid occurs. Schmoll estimates that thymine acid brings about an increase in the gouty of the elimination of uric acid by the urine, which may reach to 25 or even 50 per cent. higher than the normal amount. It is given in cachets in doses of 4 grains (0.26 Gm.) before meals. Robin prefers **quinoformine**. The practitioner may try these two remedies alternately for periods of ten days.

When the joints remain enlarged and puffy, **massage** will be of great benefit, provided all pain has gone. The **Scotch douche** succeeds in chronic cases. Baths of **superheated air** are equally useful. When a joint is disabled by large gouty deposits, **cataphoresis** has brought about good results. The joint is placed in a bath of **iodide of lithia** (2 per cent.), or of 5 per cent. **bicarbonate of potash**. The positive electrode is placed in the bath; the negative pole, moistened with hot water, is applied to the lumbar region. A current of from 150 to 200 milliampères is passed for from twenty to thirty minutes. The lithia is said to penetrate the tissues, and being brought directly into contact with the gouty deposit tends partly to dissolve it. Editorial (*Journal des praticiens*; Pract., July, 1909).

**Mineral Springs.**—A considerable number of springs to which gouty patients commonly resort are strongly impregnated with the salts of soda; it is not, therefore, surprising that not infrequently the first result of the cure is to provoke an acute attack of gout or to aggravate the symptoms with which the patient was suffering. The physicians practising at these resorts are accustomed to consider this aggravation as of good augury. Perhaps they are right, as it does happen that a patient who for some time has been laboring under the preliminary symptoms of gout feels better when the attack has

passed over and a large quantity of uric acid has been removed from the blood; but it is a rough mode of cure, and many physicians, especially the English, now advise the patients to avoid strong alkaline springs or to use their waters sparingly. Roberts resumes his opinion of the strong alkaline springs (Vichy, Carlsbad, etc.) in the treatment of gout in the following words: "It is difficult to believe that they can do any direct good, and easy to believe that they can do direct harm."

In cases of gout in which the urine constantly precipitates crystals of uric acid, it is advisable to prescribe some alkaline remedy or alkaline spring-water, to prevent the precipitation and the irritation of the kidneys caused by it; the doses should, however, be regulated by the degree of acidity of the urine, and not more of the alkaline drug is to be taken than necessary to reduce the acidity of the urine to the normal level and thus render it limpid and without deposit of crystals.

Some springs are devoid of the dangers dependent on the use of the strong alkaline waters, as they do not contain the salts of soda or only very small quantities of them; they are either aerated, contain but little besides the pure, warm water, or they contain some carbonate of lime or sulphate of lime; in many cases the free use of these springs, combined with douches, moor baths, massage, and hydrotherapeutics in its different applications, will be useful, especially against the stiffness of the joints remaining after acute attacks.

Among the most renowned **springs** of this kind may be mentioned **Buxton** and **Bath**, in England; **Aix-les-bains**

and Contrexéville, in France; Wildbad, Gastein, and Pfeffers, in Germany and Switzerland, and Sandifjord, in Norway.

#### Medicinal and Other Measures.—

Of the drugs which have been recommended against gout, **guaiac** merits special mention. It was introduced by Garrod, and is administered in a dose of 7 to 10 grains (0.45 to 0.65 Gm.) of the resin daily, ordinarily combined with **iodide of potassium** or **quinine**. It seems to have a very good effect in many cases, as it is well supported by the patients, even under protracted use. It seems to retard the return of the gouty attacks.

The treatment of gout by **radium** emanations is advocated by His, Gudzent, Bechhold, Ziegler, and others; but the method is still on trial.

Results with the **radium** treatment of 100 cases of chronic rheumatism and 28 cases of gout. Forty-seven were improved, 29 considerably improved, 5 cured, 13 were uninfluenced by the treatment, and in 6 no result was apparent. The writer adds that the majority were severe cases that did not respond to other methods of treatment. He gives the details of some of these cases. The best results occurred in the early stages of the disease. Of the 28 cases of gout only 4 were unimproved, while 24 were markedly improved, some completely cured. The writer does not believe that radium is specific in gout, but that it is most useful in certain cases. No result is to be expected in patients with bony ankylosis. His (Berl. klin. Woch., Bd. xlviii, S. 197, 1911).

**Radium** emanations were used in 400 cases of gout and chronic arthritis by the writer. He places the patient in a closed radium room for 24 to 36 sittings of two hours each. Injections of soluble radium salts near involved joints were given in addition; also **superheated air**, elec-

**tric light**, and **brine baths**. Absolute rest in bed is important. Out of 50 cases in which blood was examined before and after treatment, uric acid disappeared in 37 instances, synchronously with marked amelioration. Children were particularly benefited, but cases of senile tuberculous and syphilitic arthritis and cases of very long standing, with marked joint changes, are not suited for radium treatment. Gudzent (Berl. klin. Woch., Nov. 20, 1911).

The writer has seen none of the favorable results ascribed to radium by others. It may expel the uric acid from the blood, but without thereby influencing the severity of subsequent attacks. Still, the method is in its infancy as yet and he does not discourage its use. Inhalation is the proper method of exhibition. Large doses of **hydrochloric acid**, once thought to be eminently contraindicated, are known to prevent the formation of uratic deposits, and may be given when there is no evidence of hyperacidity. Richter (Deut. med. Woch., Dec. 21 and 28, 1911, and Jan. 4, 1912).

Edison, and after him Labatut, Levison, Chauvet, and Gilles, have advocated the **electric treatment** against the stiffness of gouty joints; by this treatment remedies are introduced through the skin by the aid of a **galvanic current**. The experiments of Labatut and other scientists have demonstrated that the alkaline substances enter into the body with the positive current, whereas the acids are introduced with the negative. The remedy employed in this way against the gouty affections is **lithia**, which is liberated by the decomposition of the salts of lithia by the electrolytic effect of the current and enters through the skin in the nascent state, and consequently in a very effective condition. Labatut conducts the dielectric treatment in the fol-



lowing way: A 2 per cent. solution of **lithium chloride** is rendered alkaline by addition of some caustic lithia or lithium carbonate, and the hand or foot which is to be treated is placed in a saucer filled with the solution, into which also the positive conductor is plunged, taking care that the conductor does not touch the skin; the negative conductor (both conductors are made of charcoal) is placed in another saucer filled with a weak solution of sodium chloride, and some part of the body, hand or foot, is put into contact with this liquid. A current of 15, 20, or 25 milliampères is used, according to circumstances, and each *séance* is of thirty minutes' duration. By the continued use of this method, I have in many instances succeeded in restoring to gouty joints the mobility which had been lost for several years. While it is also possible to dissolve tophi, some part of the swelling caused by the deposits will, however, always remain, as the tophi do not consist only of biurate of soda, but contain also new-formed connective tissue, which cannot be dissolved by the lithia.

**D'Arsonvalization** gave the writer constant success in 14 cases of muscular gout with distressing infiltration in muscles, tendons and subcutaneous fat tissue. The infiltrations disappeared. Benefit was permanent even in cases of 23 years' standing. The sittings were for from 15 to 45 minutes; from 20 to 28 sittings were required to relieve the patients completely. Andersen (*Ugeskrift for Læger*, Apr. 14, 1921).

Another useful measure is the **hot-air bath**. In all the different forms of baths, mineral bath, moor baths, Turkish and Russian baths, the heat is the common active principle. It is difficult to bear more than 50° or at

most 60° Celsius when the heat is applied as vapor bath, moist air, or hot water; but when the heat is administered by means of dry air, a far higher temperature is easily borne.

There have been invented ingenious apparatuses, by which an arm or foot may be exposed for from thirty to fifty minutes to a current of dry air heated to 100-150° C. and even more, and many observers (Knowsley, Sargent, Mendelsohn, Levison) have noticed the good effects of this treatment against the stiffness of gouty articulations, especially when it is combined with the use of **massage**.

The **electric light bath** is frequently a valuable measure, involving the application of both heat and light. The bath induces superficial hyperemia and sweating, not only reducing weight but also ridding the system of a certain amount of toxic material. The application of light has been credited with some power to promote absorption of tophi.

After an acute exacerbation, **mud baths** followed by **hot poultices** lead to improvement.

According to Soubirou, intravenous or intramuscular injections of **colloidal sulphur** are of value. Series of 12 injections each are given, with intervening periods of 10 days. In acute cases the pain, swelling and tophi soon yield, while in chronic cases lasting favorable effects on the uric acid and urine output, blood-pressure and liver are also seen.

**Removal of foci of infection** has also been emphasized in the treatment of gout.

For *chronic gouty bronchitis* the remedies on which the writer chiefly relies are pure **terebene**, in 10-minim. (0.6 c.c.) doses three times a day, and **pix pini**, 2 grains (0.13 Gm.).

made with lycopodium into a pill, of which 2 should be taken every four hours. When asthma is marked **cubeb cigarettes** will be found useful.

Gouty patients often suffer from *profuse perspiration*, not at the time of the attack but chronically, and for this **picrotoxin** is an infallible remedy, in doses of  $\frac{1}{60}$  grain (0.001 Gm.) twice a day.

**Hot baths** are undoubtedly useful in gout. To the ordinary full-length bath, containing 30 gallons, may be added  $\frac{1}{2}$  ounce (15 Gm.) of pure **terebene** and 10 drops of either **pumilio pine oil** or oil of the **Eucalyptus maculata**. An **alkaline bath** may be made with 4 ounces (120 Gm.) of bicarbonate of sodium and 10 drops of oil of bergamot. A salt bath is prepared with 6 pounds (3 kg.) of bay salt and a couple of drams (8 Gm.) of bay rum. In cases of emergency a **saline bath** may be made by pouring in a couple of bottles of any of the ordinary saline purgative waters. **Mustard**, 20 ounces (620 Gm.) of the meal, and **liquor ammoniæ**, 4 ounces (120 c.c.) or more, are also useful, and common **washing soda** is often prepared under various fancy names by drug manufacturers. Murrell (Clin. Jour., May 19, 1909).

The writer distinguishes three different clinical types of gout: 1. The digestive type, characterized by gastrointestinal, pancreatic, and hepatic disturbances. 2. The angionephritic type, in which vascular and renal affections play the chief part. 3. The neurotrophic type.

In attacks of digestive type, meat must be limited, and **alkalies** given, taking **hydrochloric acid** after meals. If the action of the liver or of the pancreas is insufficient, **calomel** or **pancreatic preparations** must be ordered. The neurotrophic type calls for strict hygiene, intellectually, morally, and sexually. Le Gendre (Revue de thérap. méd.-chir., cited in Pract., July, 1909).

The excretion of calcium in the urine in gout is lower than normal,

most of it leaving the body with the feces. Calcium chloride in 2 cases of gout, kept on a fixed diet, caused a marked fall in the uric acid output in the urine. This suggests that foods rich in calcium should be restricted in gout, viz., spinach, celery, rhubarb, endive, pork, cheese, and oatmeal, particularly the first four. Bain (Lancet, Mar. 31, 1917).

**Alkaline cures**, such as Vichy, reduce the blood uric acid and blood viscosity, and are valuable in the early, "hepatic" stage of uricemia. Later, when the kidneys are also involved, the cure may nevertheless be given if the patient is still fairly young, but care should be taken to prevent complications due to excessive blood dilution by giving sugar to increase viscosity, by restricting fluids, and sweating and purgation. **Sulphur cures** act well in uricemia, promoting uric acid elimination and stimulating the hepatic and intestinal functions. They are definitely indicated in uricemia with bronchial localization, and assist in repair of the bones, cartilages and synovial membranes. Rouzaud, Schneider and Germès (Paris méd., Aug. 30, 1924).

A visit to some spring where the application of **hot baths**, **douches**, and **massage** are combined with the use of some **aërated spring** and good vivifying air will be of use to restore the forces and the spirits of the patient. Also a sojourn in some **dry and hot climate** is advisable as well for the specific gouty symptoms as for the coexisting disease of the kidneys.

**Internal or Retrocedent Gout.**—The obscure symptoms of the so-called visceral gout require different treatment according to their nature, but in all cases it must be remembered that gout is only to be treated successfully when great care is given to the dietetic and hygienic treatment of the whole system. This cannot be regulated by one common rule, but it

must be carefully adapted not only to each patient, but to the different stages and periods of the malady. Some have advised, in these cases, that efforts be made to bring about a true external attack by means of hot mustard foot-baths, sinapisms, or ingestion of an alcoholic beverage.

F. LEVISON,  
Copenhagen,

AND

RAE S. DORSETT,  
Philadelphia.

### GRANULOMA COCCIDIOIDES.

—This is a disease resembling blastomycosis and tuberculosis, due to infection with the mold *Coccidioides immitis*, of the Ascomycetes group. Since 1896, when Rixford and Gilchrist reported the first 2 cases from California, numerous other cases have been recorded, mostly from that State, with a few scattered instances from Missouri, South Carolina, Kansas and Illinois.

#### SYMPTOMS AND PATHOLOGY.—

The primary lesions are usually in the skin or lung. In the former instance, blastomycosis or the more acute forms of tuberculosis are simulated. The condition may remain local for years, but eventually a general infection supervenes, with regional lymphatic involvement and suppuration, multiple abscesses in the viscera and tissues generally, and a fatal termination. In lung infection the symptoms simulate tuberculosis, and the pathology is likewise closely similar.

Among 23 cases described by Hammack and Lacey (Cal. and West. Med., May, 1924), the age ranged from 2 to 83 years and farm-workers outnumbered any other occupation. Subcutaneous abscesses were very common and bone lesions present in 21 cases, oftenest at the ankle and in the vertebræ. Ten patients died within 1 to 12 months. Some lung involvement was revealed by every autopsy. *Coccidioides immitis* either in pus or tissue was demonstrated in every case.

No intermediate host or carrier of the disease is as yet known. The mold occurs

abundantly in diseased tissues as doubly contoured spheres 5 to 50 microns in diameter. In the tissues it reproduces seemingly only by endosporulation, as many as 100 or more spores developing and being finally set free by rupture of the capsule. This process differentiates the condition from blastomycosis. The mold can be cultivated on artificial media such as agar and ascitic fluid (anaerobically), when it develops a mycelium with hyphæ and resembles the oidia and trichophytons.

Injection of pus or sputum intraperitoneally in guinea-pigs induces in 3 weeks a condition simulating generalized tuberculosis in these animals, with the addition of a purulent orchitis.

**TREATMENT.**—Attempts at treatment, aside from surgical procedures such as incision of abscess, thoracotomy, and amputation, have been largely unavailing. No drug has been found effective. In 2 of Hammack and Lacey's cases, subcutaneous lesions seemed to respond to X-ray treatment. S.

### GRANULOMA INGUINALE.

—This disorder, also known as *ulcerating or venereal granuloma*, is an infectious, chronic, indurated, cicatrizing growth occurring on or near the genitals of males and females, with no tendency to glandular involvement or serious impairment of the general health. Women are said to be more often affected than men. The colored races have been thought especially predisposed, but many cases in white subjects have also been reported. The disease occurs, among other localities, in Porto Rico and other West Indian islands, as well as Panama, and has been brought from there to the United States.

**SYMPTOMS.**—In the *female* the condition typically begins as a small nodule in the groin, growing slowly and becoming superficially ulcerated. As it extends, there is formed a peculiar cicatrix, somewhat like a keloid, with a spreading mass of nodules at the periphery. It is resistant to antisyphilitic treatment, and is distinguished from epithelioma by the absence of glandular involvement.

In the *male*, the disease begins, as a rule, on the penis as a papule or small nodule, which, upon further addition of nodules,

extends to the groin, causing the hair to fall out, and between the scrotum and thighs, and finally into the perineum and around the anus, into which it may pass. There is usually no deep ulceration, and very little pain or itching, but there is often a thin, sometimes offensive discharge. It is generally transmitted by sexual intercourse.

As described by H. L. Horwitz, the lesion is clinically distinctive by its chronicity and the light-red, shiny mass of granulating tissue that bleeds easily and exudes a thin, sanguineous fluid with an almost pathognomonic fetid odor. The margins of the lesions are raised and the center sunken.

Diagnostic use of tartar emetic as a therapeutic test suggested, as it is specific. In a case reported, 11 intravenous injections of 1 and later 1.5 c.c. (16 to 24 minims) of 1 per cent. tartar emetic solution in the course of a month brought rapid curative results. W. S. Ehrich (Surg., Gyn. and Obst., Jan., 1925).

**ETIOLOGY.**—Regarding the etiologic factor, there is still some doubt. Donovan described small rod-like or coccus-like parasites lying in groups or singly in mononuclear cells obtained by scraping the sores. The organism is Gram-negative and encapsulated, and has been termed *Calimato-bacterium granulomatis*. An organism of this type has been found in a large proportion of cases by recent observers. A spirochete, termed *S. aboriginalis* by Cleland in 1909, has also at times been found.

**TREATMENT.**—An ointment of salicylic acid, 30 grains (2 Gm.), and unguentum creosoti, 1 ounce (30 Gm.), has been recommended by Conyers and Daniels. The lesions have also been scraped and cauterized, and X-ray treatment has been found successful in Madras.

By far the best measure, however, is intravenous injection of a 1 per cent. solution of tartar emetic, 5 c.c. (80 minims) being given every other day, increased by 1 or 2 c.c. each time until 12 c.c. (194 minims) every other day is injected. As noted by H. Goodman, if 10 or 12 injections have cleared the lesions, another like series of injections should be urged upon the patient, as with insufficient treatment repeated recurrences may occur.

When the lesions are accessible to surgical excision, this procedure, combined with the tartar emetic, will considerably shorten the curative process. S.

**GRAVES'S DISEASE.**—EXOPHTHALMIC GOITER, BASEDOW'S DISEASE, PARRY'S DISEASE, FLAJANI'S DISEASE, HYPERPLASTIC GOITER, OR DYSTHYROIDISM.

**DEFINITION.**—This condition, commonly termed Graves's disease in English-speaking countries, is a chronic (rarely acute) affection, characterized by increased basal metabolism, weakness, wasting, emotionalism, tremor, dermatographia, afebrile heart hurry, and usually also by hyperplastic goiter and exophthalmos.

The symptomatology of the disease is widespread and points to a neuro-endocrine disturbance in which the vegetative nervous system and probably all the endocrine glands are in a state of dysfunction. There is, for instance, a varying degree of sympatheticotonia and vagotonia (one or the other predominating), associated with hyperfunction or dysfunction of the thyroid, hyperfunction of the thymus, hypofunction of the parathyroids, dysfunction of the pituitary and of the suprarenal glands, hypofunction of the islands of Langerhans and of the gonads, and other phenomena with which we are as yet unacquainted.

**SYMPTOMS.**—*Swelling of the thyroid (goiter)*, though regarded as a cardinal sign, is usually but not always present. The thyroid gland is entirely normal on inspection, though almost always there is increased palpability of the organ. In such patients goiter may occur in the advanced stages of the syndrome.

The swelling is ordinarily symmetrically distributed, of small or medium size, though occasionally it may appear so large as to produce pressure symptoms. In typical instances the mass throbs with the cardiac cycles. Palpation of the thyroid usually reveals a thrill. In typical cases, grasping the thyroid with the hand may, as in the case of a loaded sponge, reduce some of its vascularity, with temporary diminution in size of the goiter. On auscultation over the organ, a loud systolic and often also a diastolic murmur is heard. These signs are practically pathognomonic of Graves's syndrome, and in combination almost never occur in any other thyroid affection. They indicate hyperplasia with marked vascularization within the thyroid.

Occasional exceptions to this rule are noted: There may be some adenomatous infiltration, and in very chronic cases the organ may undergo fibrous or even calcareous changes. In early cases thrill and bruit may be absent because the organ has not yet reached the point of excessive vascularization. In some short-necked people goiter may never be observed by the usual means of examination, as the thyroid is intrathoracically or substernally located. Under these circumstances X-ray examination is of assistance. Rarely an accessory thyroid structure, anomalously situated in the thorax, at the base of the tongue, in relation with the ovaries, or elsewhere, may undergo hyperplasia during the course of the disease, thus explaining the appearance of a normal neck in the presence of an otherwise typical clinical picture.

The time of occurrence of goiter

varies widely. In approximately 30 per cent. of cases it may be absent or occur late in the disease. Occasionally goiter appears concomitantly with other subjective and objective manifestations. Usually thyroid swelling *follows* within weeks or months the onset of nervousness, emotionalism, heart-hurry, sweating, dermatographia, loss in weight, and even staring eyes. It is only in exceptional cases that the thyroid swelling appears as the earliest sign of the disease.

*Nervous Symptoms.*—Tremor of the outstretched fingers in active Graves's disease is a constant sign. It is an "intention" tremor, presenting eight to twelve cycles per second. Though in early cases it may be seen in but one or two fingers, it is usually observed in all of them when the disease is fairly well advanced. Tremor may be accentuated by placing a piece of paper across and over the dorsum of the hands and outstretched fingers. Or the patient may be given a tumblerful of water and requested to hold it a moment, then carry it slowly to the mouth. As the glass approaches the lips it will begin to vibrate and some of the water may be spilled if the vessel is full. Grasping the tendons of the wrist, or the muscles of the patient's shoulders, thigh, or arm, will reveal the fact that the tremor is universally present in outspoken cases, confirming the subjective tremulousness. Tremor of the protruded tongue, tremor of the closed eyelids (*Rosenbach's sign*), choreiform movements, especially in younger patients, and tremulousness of speech, are commonly observed. The voice is commonly high-pitched and stridulous.

*Mental phenomena* in Graves's disease vary from a mere acceleration of the psychic functions to actual outspoken psychoses. With the quickening of walking, sitting down and arising, eating, and talking, there occur emotional changes with impatience, irritability, restlessness, and spells of crying or laughing on the slightest provocation. There is a diminution of inhibition with an abbreviation of the threshold of emotional reaction, so that relatives and friends may complain that the individual is acting queerly. Occasionally, in addition to emotionalism and hysteria, there may be an undue desire for intellectual display. Talkativeness, most often to the point of absurdity, is common. As a result of excessive verbosity the patient is apt to get into difficulties and misunderstandings with those about him. Consciousness of changes in behavior is common but uncontrollable, and the patient is apt to complain in somewhat this fashion: "Doctor, I know I talk too much, but how can I stop it?", or "I feel dreadfully miserable and ashamed of myself, for I cry over nothing,—I have no control over my nerves."

It might be stated that in all cases of Graves's disease there is an approach toward the borderline between sanity and insanity, the susceptible individual being in danger of acquiring a psychosis at any time. The manic-depressive type of psychosis, melancholia, dementia precox, and other forms of mental aberration may be seen. The bibliography on the subject of relationship of insanity to Graves's disease is ample, containing such names as Biggs, Buckley, Packard, Wimmer, Philips,

and others. Approximately 3 per cent. of my own series of Graves's disease subjects have had a complicating major psychosis.

Exaggerated reflexes, marked insomnia, and quite frequently neuritis affecting a limb, more especially the shoulder and arm of one side, are common. A feeling of weakness in the knees and calves of the legs is often an early and distressing symptom, becoming occasionally so marked as to result in a sudden giving way of the limbs. An incident of this sort may lead to the inference on the part of strangers that the patient is intoxicated.

Rarely, epilepsy, chorea, Parkinson's disease, hysterical hemiplegia, myasthenia gravis, encephalitis lethargica, and paresis are encountered. The muscles of the eyes involved in convergence may not only become defective, but paralysis may affect the external and internal recti muscles as well.

*Circulatory Symptoms.*—Circulatory phenomena, especially heart-hurry, are important. The tachycardia is afebrile, not amenable to the influence of digitalis even in large doses; it is of chronic duration, occurring both during waking and sleeping hours; its severity is usually in direct proportion with the severity of the disease and the height of the basal metabolism, and in progressive cases it leads gradually to various forms of cardiac irregularities, hypertrophy with dilatation and, finally, decompensation.

Cardiac degeneration of varying degree is common, and depending upon the degree of dilatation, is often associated with one or more valvular insufficiencies and corresponding murmurs.

Palpitation, bitterly complained of by most patients, is not indicative of the severity of cardiac damage. A heart in good compensation and rhythm may give rise to severe palpitation, while another heart with impending decompensation may not lead to much subjective discomfort.

The term "goiter heart" must be qualified. The heart in a subject of Graves's disease and hyperthyroidism, being persistently poisoned by known and unknown toxins, may be termed the *thyrotoxic goiter heart*. A heart embarrassed by pressure of a goiter, toxic or non-toxic, substernally or intrathoracically located, is termed *mechanical goiter heart*. If the hyperplastic goiter of Graves's disease happens to be so large or is so located as to cause compression of nervous, vascular and respiratory structures, a combination of "thyrotoxic" and "mechanical" goiter heart may exist in the same patient.

The pulse rate in Graves's disease varies widely. While in a patient undergoing remission, though still suffering from bulging eyes, large neck and the like, the pulse rate may be found not to exceed the normal, in active cases the rate may reach 200 per minute. The average pulse rate in typical instances of active Graves's disease is approximately 120 to 160 per minute. In cases of auricular or ventricular fibrillation, the pulse deficit must be taken into account. The pulse rate, with increased palpitation and dyspnea, is capable of flaring up on the slightest physical or mental excitation and may give rise to sensations of impending death.

I have found, with other observers, that the basal metabolism in Graves's

disease is indicated by the heart rate with dependable precision. Thus the pulse rate is a good criterion of the severity and progress of the disease, as well as the results of therapeutics.

Uncommonly, in unduly chronic cases and recovery under adequate therapeutics, an abnormal *slowness* of the heart may be observed, the rate reaching 60 or thereabouts. Unless there are tangible evidences of myxedema, the temptation to administer thyroid extract in a case of this sort must be resisted, as it is apt to lead to a relapse of the former condition.

*Peripheral Vascular Symptoms.*—In many respects the phenomena referable to the blood-vessels in Graves's disease resemble those observed in aortic regurgitation, excepting that in the latter condition the diastolic pressure is low. Throbbing of the superficial vessels and of the abdominal aorta, and a capillary pulse are commonly seen. Christie, among others, calls attention to the possibility of confusing exophthalmic goiter with aortitis since there is apt to occur an increased transverse percussion dullness over the root of the aorta, associated with a palpable systolic pulse and diastolic impact over the aortic area and occasionally a distinct tracheal tug.

Though the excessive throbbing universally observed would appear to produce an increased systolic blood-pressure, the reverse is usually seen. It is only in advanced cases with damage to the circulatory, renal, and other vital structures, that hypertension in Graves's disease may be observed. In the average case the systolic blood-pressure is low, and the diastolic is comparatively high, giving rise to a high pulse pressure.

As already noted, excessive vascularity of the thyroid is pathognomonic of typical Graves's disease, being responsible for much of the swelling of the organ and for the throbbing, thrill, and bruit over the mass.

The blood output from the heart in 11 exophthalmic goiter patients was 80 (in the female) to 100 per cent. (in the male) above normal. This entails a considerable increase in the work of the heart, since the systolic pressure is usually somewhat increased. The diastolic pressure is slightly below normal. Liljestrand and Stenström (*Acta Med. Scandinav.*, lxxiii, 99, 1925).

Edema, especially of the ankles, at times extending upward to the knees, with a tendency toward general anasarca, is indicative of a weakening compensation due to myocardial degeneration. This is a likely occurrence in the type of cases in which the syndrome accentuated itself especially upon the circulatory system (cardiac type). Edema which does not pit on pressure is occasionally encountered, due to a myxedematous admixture. In protracted cases, edema of the lower eyelids is commonly observed in association with the exophthalmos. Again, transitory swellings of the face or elsewhere may be due to angioneurotic edema. Maude (quoted by Putnam) has described such swellings occurring in various parts of the face, neck, arms, and elsewhere, and I have likewise observed transient facial puffiness in some instances.

*The Eyes in Graves's Disease.*—The most important eye signs in this affection are exophthalmos, Dalrymple's sign (retraction of the upper lid with widening of the palpebral fissure so that a band of sclera is visible be-

tween the lid and the edge of the cornea), von Graefe's sign (lagging of the upper lid on the downward movement of the eyeball), Stellwag's sign (imperfect power of winking), and Moebius's sign (a diminution or absence of convergence). Other eye signs to be found are the Boston sign, depending upon a "spasm" of the upper lid on its downward course when following an object for a short distance; Kocher's sign, consisting of a slight momentary retraction of the upper eyelids on gazing at some object moved up and down; Rosenbach's sign, or a trembling of the upper lids when the eyes are closed; the Jellinck-Teillais sign, consisting of a brownish discoloration of the eyelids often appearing as a ring around the orbit; and Clifford's sign, which is the difficulty of everting the upper lid. Tremor of the eyeballs, varying degrees of excessive dryness or excessive moisture of the eyes, and a feeling of pressure behind the eyes in the event of marked exophthalmos, are frequently present. A bruit over the eyeball, synchronous with the heart beat, is an inconstant phenomenon described by Snellen, Donders, Hunter, Carrington, Drummond, Riesman, and Herring.

The bruit over the eyeball in exophthalmic goiter is a rhythmic murmur, synchronous with the pulse. The patient closes his eyes and the bell of the stethoscope is placed over the globe. A continuous hum due to the muscles of the eyelid can soon be distinguished from the bruit. David Riesman (*Jour. Amer. Med. Assoc.*, Apr. 29, 1916).

Rarely, nystagmus may be observed. Ulceration of the cornea may result from prolonged exposure of the ocular conjunctiva in consequence



of extreme exophthalmos. Imre points out that the ocular tension is disturbed; there are more cases with high tension than with low, and there may be a remarkable difference of tension between the right and left eyes. Ophthalmoscopic changes usu-

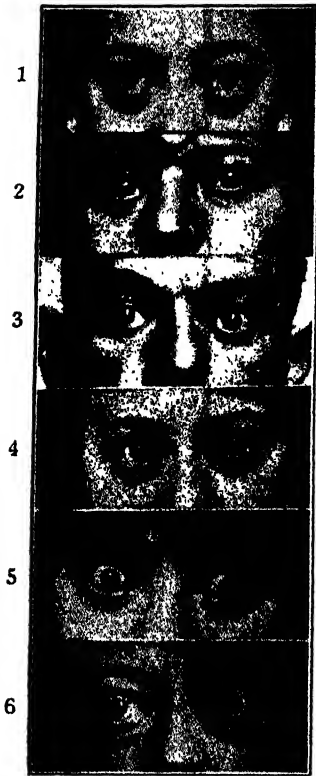
Paralysis of the eye muscles is of rare occurrence.

Exophthalmos of varying degree is observed in approximately 70 per cent. of patients. The time of its occurrence varies, it being usually observable shortly after other evidences of the disease, such as nervousness, palpitation, heart-hurry, tremor, loss in weight, sweating, and changes in behavior are noted. Occasionally, following a marked psychic trauma, such as an automobile accident, a shipwreck, or a conflagration, exophthalmos may occur concomitantly with the other characteristic signs and symptoms of the disease; rarely protrusion of the eyeballs is the first evidence of the syndrome. In cases without exophthalmos, a larval von Graefe's sign is usually elicited.

The degree of exophthalmos may vary from a mere stare to impending or actual dislocation of the eyeball from its orbit. Marked protrusion of the eyeballs with inability of the lids to close over them, resulting in excessive irritation of the ocular conjunctiva from exposure, may give rise to corneal ulcers and infection.

The cause of exophthalmos is variously discussed by Marañon, O'Day, Marine and Lenhart, and others. I believe that stimulation or irritation of the cervical sympathetic in Graves's disease produces bulging of the eyeballs; the space in the orbit produced by the bulging is gradually filled with fat as a secondary phenomenon. Venous congestion of the orbit may occur later as a result of proptosis.

Occasionally exophthalmos is unilateral; or if bilateral, may be unequal, one eye bulging to a greater degree than the other. In severe unequal exophthalmos diplopia may oc-



1, "Pop eyes" in girl of 12. 2, Beginning exophthalmos in Graves's disease of severe type. 3, Moderate exophthalmos, greater in left eye, in man of 39 with impending psychosis. 4, Exophthalmos greater in right eye. 5, Marked exophthalmos of 8 years' duration. 6, Marked exophthalmos with edema of eyelids, the clinical picture aggravated by thyroidectomy about 2 years before this picture was taken.

ally are not marked or typical; there may be seen some dilatation of the arterial vessels and arterial pulsation. Optic atrophy may occur as a late sequel, dependent upon marked exophthalmos of long duration with prolonged traction of the optic nerve.

cur until the more protruding eye recedes to resume the necessary co-ordination with its fellow.

Presented with a case of exophthalmos, one must not hastily conclude that the sufferer has Graves's disease. Among conditions other than Graves's disease giving rise to bulging eyes are attacks of asthma, angina pectoris, thrombosis of the superior longitudinal sinus, paralysis of the ocular muscles, pathological conditions within or behind the orbits or of the antrum of Highmore, and hydrocephalus. "Pop eyes," a congenital condition dependent upon shallowness of the orbits, an excess of orbital fat, or singularly large eyeballs, must especially be borne in mind.

*The Gastro-intestinal Tract.*—The teeth and gums may be infected and bear a causal relationship to the disease. The tongue may or may not be coated, depending upon the condition of the digestive tract. In the majority of instances a coarse tremor may characterize the protrusion of the tongue. The saliva, though rarely diminished, is occasionally increased to a troublesome extent. Dysphagia, due to pressure of a rapidly growing goiter, is not commonly observed in Graves's disease. A feeling of a "ball in the throat" is, however, commonly complained of, even in the absence of thyroid enlargement, and may be due to *globus hystericus*.

The appetite is usually very good in typical cases. This, combined with excessive thirst, persistent loss of weight and strength, and a deficient carbohydrate tolerance, so closely resembles diabetes mellitus that the diagnostician must be constantly on his guard.

Nausea and vomiting are commonly observed. Vomiting and gastric distress may be so severe, especially if associated with diarrhea, as to endanger the life of the patient. The gastric acidity varies between hyperchlorhydria and hypochlorhydria. Often there are evidences of pyloric spasm. Not a few patients have, in my experience, believed themselves suffering with nervous indigestion, gastric ulcer, and even gall-stones. It must be recalled that a crisis in Graves's disease may assert itself almost anywhere, especially with reference to the stomach, gall-bladder and appendix.

While constipation may occur and may be of etiological importance, diarrhea is most often observed. Diarrhea is oftentimes resistant to treatment and so severe as to terminate the life of the patient through intestinal hemorrhage. Ordinarily diarrhea is due either to intestinal toxins, vagotonia, or both. Occasionally mucous colitis may be associated. Jaundice and even acute yellow atrophy of the liver are rarely observed.

The character of the feces varies widely. They may be normal, or they may present certain features of pancreatic or biliary disease, with clay colored stools containing fat and undigested meat fibers. In severe instances great quantities of mucus and blood may be expelled.

*Cutaneous Symptoms.*—The skin is thin and moist to the touch. Though secondary anemia may be present, the skin is of rather plethoric hue, due to peripheral vasomotor changes. Occasional areas of edema may be due to cardiac failure, and pit on pressure. This must not be confused

with the pale doughy areas which do *not* pit on pressure because of their myxedematous nature. The temperature of the skin is usually higher than in normal individuals.

Dermographia (writing on the skin) is constantly present in Graves's



Illustration of Addisonian patches on chin, arms, and hands, in patient with moderately advanced Graves's disease with slightly unequal exophthalmos.

disease and is an evidence of vasomotor imbalance or ataxia. With the dorsal aspect of the finger or with a blunt pointed probe, markings upon the skin (preferably the back) may be produced by employing moderate pressure. There will be an immediate pallor along the course of the trac-

ings, followed by a reddening within five to ten seconds, which may reach the maximum redness and begin to fade within from twenty to sixty seconds. Occasionally the redness remains for a few minutes and presents a pale margin on each side. Various types of dermatographia are encountered. Thus, the tracings may present a preliminary redness, to be followed by extreme pallor—just the reverse from the above, and with a red margin on each side.

Hyperidrosis is a common and annoying symptom. Not only is the entire skin excessively moist at all times, but the sweating of the palms of the hands and soles of the feet is especially complained of. Excessive sweating may be a cause of insomnia, the patient's bedclothing becoming veritably drenched, requiring changing during the night.

Erythema of the skin is practically the rule in Graves's syndrome. An area of reddened skin on the upper anterior aspect of the chest from the neck downward, the lower border of the area appearing as a rounded margin, not unlike the shape of a baby's bib, is pathognomonic. Erythematous blotches are commonly seen elsewhere and are inconstant.

Lian found, on examination of soldiers complaining of palpitation, a hypersensitivity of the skin over the thyroid gland. The organ may or may not be swollen. Lian regards this sign as diagnostic of the early stages of Graves's disease.

Pigmentation is commonly observed, suggesting involvement of the adrenal glands. Falta, Kocher, and Sainton and Fayolle are among the names in the literature on relationship of pigmentation with Graves's

disease. Often this is so striking as to resemble that seen in Addison's disease.

The writers observed a case of exophthalmic goiter in a woman, aged 62, with coexisting Addisonian pigmentation. A modified Ehrmann test (citrate blood from a punctured vein applied to an enucleated frog eye) elicited a positive response, the mydriasis reaction persisting for 3 minutes. The Goetsch skin reaction was also distinctly positive. In 1 of their cases, with less pronounced pigmentation, the induced mydriasis was manifest within 1 minute. The writers hold that change of the thyroid with subsequent hyperthyroidism was the first phase of the disease; hyperadrenia, from exaggerated secretion of the suprarenal medulla, the second phase. Chauffard and Girot (*Revue Franç. d'Endocrinol.*, June, 1925).

Among miscellaneous skin manifestations in Graves's disease may be mentioned pruritus of varying degree, frequently associated with glycosuria; urticaria, occasionally observed in association with intestinal symptoms; eczema; psoriasis; petechiæ and angioneurotic edema. Rarely trophic edema occurs, as in a case reported in 1920 by Parhon and Stocker. The nails may become brittle and weak. The hair on the scalp, eyebrows and lashes may become sparse; alopecia, though not of special importance, is common. Peripheral stimuli are conducted with great rapidity, and are more acutely and intensely translated. Joffroy's sign, consisting of failure to wrinkle the forehead when looking up, is commonly seen.

*Respiratory Symptoms.*—Symptoms referable to the upper respiratory tract, especially rhinitis, sinusitis, tonsillitis and pharyngitis, are frequently seen, and may play an etiological rôle.

The voice in subjects of Graves's disease is often high-pitched and tremulous, resembling in some respects the voice in paresis of the vocal cords. An extension downward of inflammation of the pharyngeal vault may lead to chronic laryngitis with consequent hoarseness and cough. Irritation and compression of the inferior laryngeal nerve, with vocal abnormality, is rare. Cough may be due to coexisting phthisis, an enlarged thymus, or an associated hysteria.

Diminished respiratory expansion with an increased respiratory rate, due to the heightened metabolism, is almost constant. Pulmonary tuberculosis is often associated with Graves's disease. Remarks on this relationship are made by many observers among whom are Caro, Chinzinger, Swan, and Gallotti. Asthma has been observed in association with Graves's disease by Hofbauer and Curschmann, who believe that both diseases have a sort of common origin.

*Genito-urinary Phenomena in Graves's Disease.*—Menstrual disturbances are common in Graves's disease. Amenorrhea is frequent and may persist for many months or even a year or longer. Quite as often menstruation may be irregular in occurrence, duration and quantity and, rarely, menorrhagia occurs.

Sterility, especially of the female, is almost the rule during active Graves's disease. It is only when the patient is on the road to recovery or has become entirely well that normal menstrual function and fecundity are established. Though conception may occur during the course of the disease, pregnancy

rarely goes to term, the most usual occurrence being spontaneous abortion. If, however, pregnancy has progressed to term during Graves's disease, the obstetrician must be on the alert for post-partum hemorrhage due to diminished blood calcium content.

Gynecological lesions such as myomata, fibroids, cysts, and the like are commonly found associated with Graves's syndrome and may or may not be etiologically related.

Increased frequency of urination, both diurnal and nocturnal, especially the latter, is common. Nocturia, as often as 10 to 15 times nightly, is a contributory cause of insomnia. Polyuria may for weeks or months be a forerunner of Graves's disease.

Glycosuria, usually of moderate degree, is common. The same is true of hyperglycemia. Both these phenomena are of temporary duration in the average case, to disappear with improvement or cure of the patient. In a small percentage of patients true diabetes mellitus may be associated with Graves's disease; Fritz, in 1919, reported 39 cases; Holst observed 4 cases of similar nature.

Albuminuria of transient nature is uncommonly observed, and may be attributed to many factors, among which are a coexisting nephritis, irritation of the kidneys by causal toxins in the blood, or passive congestion of the kidneys due to cardiac incompetency.

The increased catabolism results in a greater output of the urea nitrogen, total nitrogen, uric acid, and phosphates in the urine. In 1907 Forsbach pointed out that the creatinin content of the urine is greatly reduced in Graves's disease.

*Fatigability* and weakness are common complaints. This may occur early, but as the syndrome advances, lack of physical and mental strength and endurance is constant. The patient may experience an impulse to be up, about, and doing, but disappointment follows shortly after the effort. The sudden giving way of the legs has already been mentioned.

*Loss of weight* occurs in the majority of patients suffering with the active form of Graves's disease. In the more acute forms, patients may lose one-half the body weight in a few weeks. In the average patient, a 40 per cent. reduction of weight within a few months is common. Despite the increased metabolism, however, an apparent paradox is seen when, uncommonly, a patient will advise the examiner that there has been some *increase* in weight since the onset of the disease. This is probably the result of an enormous intake of food consequent upon the ravenous appetite associated with the disease. In the course of the syndrome, however, such a patient is likewise very apt to lose substantially in weight.

A sensation of *excessive warmth* or feverishness is present to some degree in practically every active case. This, of course, is due not only to the quickening of the metabolic processes, but likewise to vasomotor instability. While in the very acute form of the disease the temperature may rise to 110° Fahrenheit, as in a case reported by Rendu, in the average patient the rise in temperature varies between  $\frac{1}{2}$  and 2 degrees above normal. These patients do not get along very well during the summer months, but are greatly tolerant to winter weather.

*Augmentation in height* during active Graves's disease has been stressed by Holmgren, Gram, and others. I believe that this occurs in young subjects only, and is due to physiological changes (incident to adolescence) which, becoming exaggerated through the augmented metabolic processes of the disease, lead to excessive height. In a recent patient of mine, a girl of 14, five feet in height, with very active Graves's disease, there was an increase of 11 inches within 6 months. It is likely that pituitary involvement in this syndrome plays some rôle in this phenomenon.

*Miscellaneous Symptoms.*—Putnam remarks that the fingers may become tapering and very movable in their articulations. The spleen, the thymus, and the lymph glands generally are commonly enlarged.

Frequently there occurs an atrophy of the gonadal structures and rather marked shrinking of the breasts, probably due to general loss in weight. On the other hand, Basedow (quoted by Putnam) reports a case of enlarged breasts in a man.

Observers of many patients with Graves's disease occasionally see cases of the syndrome with myxedematous changes interspersed. I have seen a number of patients in whom, following an attempt at curtailment of thyroid secretion by X-rays or by thyroidectomy, hypothyroidism was superimposed upon very evident persisting signs of Graves's disease. Again, the so-called "burned out" thyroid, occurring secondarily to a period of excessive stimulation, is responsible for a number of instances of myxedematous symptoms.

*Vagotonia* and *sympatheticonia* have been largely discussed by Eppinger

and Hess, Pottenger, and Brown, on the premises that the autonomic or vegetative nervous system is intimately related to the endocrine organs and inseparably associated with the etiology and symptomatology of Graves's disease. Thus, depending upon which division of the vegetative nervous system dominates the symptomatology, the patient is classified either as sympatheticotonic or as vagotonic (parasympatheticotonic) in nature. Sympatheticotonia is produced either by stimulation of the sympathetic, inhibition of the vagus, or both. Vagotonia (parasympatheticotonia) is produced by stimulation of the vagus, inhibition of the sympathetic, or both. Since in a given patient any attempt to check up the clinical findings relative to sympatheticotonia, on the one hand, and vagotonia, on the other, yields clinical inconsistencies, such a classification is only of relative value.

*Remissions and crises* in Graves's disease are to be borne in mind. In the case of average severity, the syndrome, if untreated, reaches its peak at about the ninth month of the disease, and remains in this toxic state with severe tachycardia, tremor, sweating, weakness, loss of weight, and instability of the psychic and emotional centers for approximately 3 or 4 months. This is known as a crisis, following which there is a gradual lull or recession of eight or nine months' duration. This is known as the period of remission. Following this another crisis may be expected, to be followed by another remission. A crisis may be so severe as to prove fatal from cardiac failure, a psychosis, or some intercurrent condition. After the thirtieth month of the disease,

the average sufferer from Graves's disease presents a symptomatology that is more or less constant in severity.

**DIAGNOSIS.**—In the presence of the classical cardinal symptoms, namely, exophthalmos, goiter, tachycardia, and tremor, there is no disease in the domain of medicine that is diagnosed with greater ease than is Graves's disease. On the other hand, in the absence of goiter, exophthalmos or both, in no other affection is the diagnosis as difficult. Within recent years we have been realizing that there are more cases of Graves's disease in our midst than were ever suspected, because heretofore there were great numbers of atypical forms of the affection which were unrecognized.

I would suggest the following as the most constant evidences of *active* Graves's disease: (a) Increased basal metabolism; (b) afebrile heart-hurry; (c) a reduction in the threshold of emotional reaction; (d) tremor, especially of the outstretched fingers; (e) dermatographia; (f) fatigability; (g) a relative immunity to cinchonism. These symptoms, in combination, are seen in no other disease. The important signs (h) goiter, and (i) exophthalmos, are inconstant though usually present, and when absent at the time of examination, one or both may appear some time later in the course of the affection. Rapid heart and increased basal metabolism in rare instances may be absent during a *remission* of the disease.

In the presence of focal infection or a history of psychic trauma, such signs and symptoms as persistent insomnia, irritability and nervousness, palpitation, a heart rate of above 90,

inexplicable looseness of the bowels, and loss in weight, should lead to a strong suspicion of Graves's disease.

Rarely the disease may have a sudden occurrence and go through a very brief and stormy course. Thus, in the case of one of my patients, a munitions worker of 32, there was an explosion in a building within a block from the place where he was at work. Though physically uninjured, the shock rendered him unconscious, and shortly after he was picked up there was severe trembling, exophthalmos, tachycardia, hyperidrosis, and other frankly outspoken evidences of Graves's disease. In another case, a woman developed the disease almost immediately after a fall from a ladder. In still another, a man of 42, an automobile accident was the cause of an immediate onset of the disease, though he presented no signs of physical injury.

In the average case the disease develops insidiously, weeks or months after the occurrence of vague signs and symptoms. Occasionally goiter is the only subjective complaint, and the patient, stimulated by the causal toxins, asserts that he is feeling fine until such added complaints as loss in weight, palpitation, sweating, weakness, trembling, and insomnia are elicited by the physician.

Only a certain type of humanity is susceptible to Graves's disease, the remainder being relatively immune to this affection. The earmarks of susceptibility may be stated briefly as follows: (1) Heightened cerebration; (2) emotional instability; (3) excitable heart with labile pulse; (4) vasomotor instability asserting itself especially in dermatographia and hyperidrosis; (5) sparkling or brilliant

eyes, especially during conversation or active attention, and (6) an unduly palpable thyroid gland.

The **differential diagnosis** of Graves's disease is a topic that could be discussed at great length. For our purpose the most important conditions to be differentiated are the various non-hyperplastic goiters (especially toxic adenoma), pure hyperthyroidism with or without goiter, hysteria, neurasthenia, neurocirculatory asthenia, effort syndrome, paroxysmal tachycardia, the various digestive disorders (nervous indigestion, peptic ulcer, gastric carcinoma, intestinal and biliary disease), diabetes mellitus, and phthisis. Rarely such conditions as Addison's disease, spinal affections and even insanity must be borne in mind in the differential diagnosis.

**Diagnostic tests** in Graves's disease may be employed in doubtful cases or as a means of corroboration, but should never be employed as a mainstay in diagnosis. Moreover, laboratory tests in the diagnosis of Graves's disease do not differentiate between this syndrome and the hyperthyroidism of toxic adenoma. In other words, these tests tend to confirm the presence or absence of thyroid hyperactivity irrespective of the existence of Graves's syndrome.

The *adrenalin test*, first described by Emil Goetsch in 1918, depends upon the reaction of the patient to subcutaneous injections of 0.5 c.c. of 1:1000 solution of adrenalin chloride. According to Goetsch, a "positive" reaction is characterized by an accentuation of all signs and symptoms. There has been considerable literature evolved about this test and the majority of observers are inclined to doubt its efficacy. Among these are

Frazier and Wilson, Garnier and Block, Lueders, Dowden, Sandiford, Boothby and Sandiford, Peabody, Sturgis, Tompkins and Wearn, Russell, Millet and Bowen, and Van Wagonen. In my personal experience with the adrenalin test, I have concluded that a "positive" reaction is indicative of hypersensitiveness to adrenalin, not necessarily of hyperthyroidism.

The *basal metabolism test* is a useful guide not only in diagnosis but in evaluating the results of therapy. It must be borne in mind that aside from physiological variations in basal metabolism in normal individuals, excessive catabolism may be observed in diseases other than hyperthyroidism. Acute febrile conditions, such chronic infections as tuberculosis and syphilis, malignant disease, chronic cardiac and renal affections, the anemias including leukemia, the ingestion of caffeine, strychnine and other drugs, diabetes mellitus, and pituitary disease are likewise associated with a higher than normal basal metabolism.

The highest basal metabolism observations are associated with hyperthyroidism, and Boothby has properly remarked that approximately 95 per cent. of all abnormally increased basal metabolism rates observed in practice are due to thyroid hypersecretion. In Graves's disease the basal metabolism may vary from plus 15 to plus 100 or more, depending upon the severity of the affection.

Some practical points concerning basal metabolism observations are worthy of note: (1) Determinations are reliable only for the time when they are taken, and must be taken frequently in order that proper con-



clusions can be drawn; (2) the preparation with the associated anticipation by the patient may lead to a temporary and even prolonged aggravation of the syndrome with corresponding exaggerated high reading; (3) errors by the technician are very frequent; (4) there is a relationship between basal metabolism readings and the pulse rate which is so constant that many observers are depending upon pulse rate in lieu of basal metabolism determinations. The exceptions to (4) are instances of auricular fibrillation with a pulse deficit, remissions when the pulse rate may be considerably lower than would be indicated by the basal metabolism reading, and the occasional patient who presents, during the active stage of the disease, a pulse rate so high as to be entirely out of proportion to metabolic findings.

The *quinine test*, which I first described in 1920, depends upon the relative immunity to cinchonism possessed by subjects of hyperthyroidism. The patient is given a dozen capsules, each containing 10 grains of quinine hydrobromide, and ordered to take one capsule before meals and at bedtime. By the time 30 or 40 grains have been taken, there develops in persons whose thyroid is normal a sense of fullness in the head, impaired hearing with tinnitus, dizziness, occasional headache, and often gastric and bladder discomfort. In hyperthyroidism no symptoms develop from the daily administration of quinine hydrobromide in the above doses, even if given during a period of weeks or months; indeed, improvement in the Graves's syndrome is common. Cinchonism may not develop until all active evidences of

hyperthyroidism (with or without Graves's disease) have disappeared. Hence this test is likewise useful as an index of recovery, though in many instances recovered patients may still possess a degree of immunity to cinchonism. The quinine test in hyperthyroidism is associated with approximately 5 per cent. of errors; it is harmless to the patient and is practical, dependable and inexpensive.

The *hyperglycemia test* depends upon the diminished carbohydrate tolerance common in Graves's disease. This test is not pathognomonic, but serves to supplement other findings.

The *Kottmann test* is a photo reaction. To 1 c.c. of fresh serum are added 0.25 c.c. of an 0.5 per cent. potassium iodide solution and 0.3 c.c. of a 5 per cent. solution of silver nitrate. The resulting suspension of silver iodide in the serum is exposed to light of sufficient intensity and developed by the addition of 0.5 c.c. of a 0.25 per cent. solution of hydroquinon. The resulting color reaction determines the presence or absence of hyperthyroidism. Considerable interest has been displayed regarding the usefulness of this test; on the other hand, its reliability is called into question by quite a few observers. E. Lauda, for instance, found a positive reaction in three cases of carcinoma, and M. Schur found the test useless as an indicator of thyroid activity.

Other tests of lesser interest are the *complement fixation test* described by Koopman, Berkeley and Koopman, and Berkeley, in which it was discovered that the blood of some patients with Graves's disease binds complement in the presence of an antigen made from normal thyroid

glands; Starlinger's *blood test*, depending upon the finding that in thyroid hyperfunction there is a diminution of fibrinogen in the venous blood; Parisot and Richard's *thyroid test* ("the sign of the thyroid"), in which slowing of the pulse of a subject of hyperthyroidism follows injections of thyroid extract; the *atropine test*, depending upon the responsiveness of hyperthyroid subjects to hypodermic injections of atropine sulphate; the *pituitary test* of Baudouin and Porak, depending upon a slowing of the pulse within 2 minutes after the injection of 1 c.c. of posterior pituitary solution; the *mydriasis test* of Loewi, in which instillation of a drop of 1:1000 adrenalin chloride solution into the conjunctival sac produces mydriasis within a half hour.

The most important means of diagnosis of Graves's disease is, of course, the properly trained senses of the equipped internist. The most useful tests that may be employed as supplements are, in my experience, basal metabolism determinations and the quinine test.

**ETIOLOGY.**—Graves's disease occurs in both sexes, at all ages, and in almost every clime. Hereditary influence has often been demonstrated when two or more members of the family suffer with this disease. Aside from my personal observations, in which approximately 10 per cent. of patients presented evidences of heredity, the literature abounds in reports of this nature. Packard, Rosenberg, Bumstead, Hector Mackenzie, Ricaldoni, Harvier, Tilmant, Souques and Lermoyez, Lenz, Climenko, and others, have reported multiple instances of Graves's disease in the same family.

Graves's disease is seen most often

during periods of greatest sexual or active adult life, though infancy, childhood, and old age are hardly immune. In Sattler's compilation of 3477 cases, 184 occurred in patients under 15. Klaus, in 1914, reported a case in an infant 9 months old. Bulford reported a case in a girl of 6. In my own series of cases, there were 21 patients whose ages varied between 5 and 13 years.

Because of the greater complexity of the gonadal apparatus, the more active sexual changes, and the finer adjustment of the emotional mechanism, females are more prone to Graves's disease than males. There is approximately one male subject of Graves's disease to every 4 females.

Graves's disease is most common in Caucasians, probably due to the greater mental activities and strife characterizing the march of civilization. The high-strung temperament of the Hebrews, the Irish and the Latinic races renders them especially prone to this affection. Mongolians are next in order of racial susceptibility. The Negroes appear relatively immune to Graves's disorder, probably because of their phlegmatic makeup. Redfern, of St. Louis, states that in the outpatient department of the Barnes Hospital, of 29,000 Negroes examined, only 9 were cases of Graves's disease.

The writer observed 2 cases of exophthalmic goiter in husband and wife, due probably to contagion. The Wassermann test was positive in both patients. *Syphilitic infection* may give rise to exophthalmic goiter, and the author cites in this connection 5 analogous cases found in the literature. Kooperman (Belgian Corresp. to Jour. Amer. Med. Assoc., Dec. 20, 1924).

Among the factors which may assist in the diagnosis of *syphilitic* exophthalmic goiter the writer cites (1) response to antiluetic treatment; (2) the Wassermann reaction; (3) presence of the various stigmata of hereditary syphilis in the patient's antecedents, and (4) association with the goiter of maladies known to be of syphilitic origin. E. Schulmann (Med. Jour. and Rec., Sept. 17, 1924).

Most observers find that in regions where endemic goiter prevails, Graves's disease is relatively uncommon, though Dock believes that Switzerland and France are exceptions to the rule. In general it may be stated that Graves's disease is more common where simple goiter least abounds, as along the seacoasts. Though simple goiter, because of certain geographical conditions, is endemic in many parts of the world, such is not the case with Graves's disease. It might be added that in regions of the world where life's struggles and activities are at their highest point, exophthalmic goiter is most common, but this does not amount to endemicity.

Theories of the cause of Graves's disease are varied and numerous. Graves, for instance, regarded the disease as a dyscrasia of scrofulous and circulatory origin. Moebius, Renaut, Bécclère, Marie, Ballet and Enriquez, and others believe that Graves's disease is due to a hyperthyroidization of the body.

The gonadal theory, based upon the relationship between the thyroid gland and the ovaries, has many supporters. Salmon believes the syndrome to be due to a destructive lesion of the pituitary body. Since there are many reports of benefit through pituitary opotherapy, this

theory seems to have some support. The theory that the thymus is largely, if not wholly, responsible for Graves's disease is held by Hart, Garré, Capelle, Bircher, Markham, Matte, Nordman, and others, who point out that in the majority of patients there is a persistently enlarged thymus gland. Eppinger, Falta, and Rudinger (quoted by Putnam) believe that the disease is due to thyropancreato-adrenal disturbance in which hyperthyroidism causes excessive adrenal activity and inhibits the pancreas.

The autointoxication theory held by McCarrison, Gaylor, Epstein, Thompson, Blum and others is based upon the physiological observation that the thyroid is a detoxicating organ, and that toxins, bacterial or otherwise, by making undue demands upon the thyroid, render this organ incapable of performing fully its immunizing functions, resulting in thyroid hyperplasia. This is closely related to the theory of Sajous in which the syndrome is the result either of endogenous or exogenous toxins, or of trauma, physical or psychic, leading to an overactivity of the thyroid and adrenal structures.

A large percentage of patients with exophthalmic goiter have enlarged tonsils and adenoids, and give a history of repeated attacks of acute tonsillitis. It is not uncommon for them to date the beginning of the goiter to one of these. Infections of the nose and throat are undoubtedly the commonest to which man is subject, and many of our ills might, if one were so disposed, be credited to them. If, as held by Sajous, the thyroid secretion is an important element against infections, it is not impossible that it is stimulated to overactivity when occasion calls for it, and if this is too

often repeated the gland may become enlarged and a pathologic condition induced. It is not a rare thing to find that a rapid enlargement of the thyroid with characteristic symptoms of overactivity has immediately followed a particularly severe tonsillar infection. S. P. Beebe (*Jour. Amer. Med. Assoc.*, Aug. 29, 1914).

In 52 patients treated by the writer, some infection was present in the mouth, tongue, teeth, nose, tonsils, pharynx or larynx. In 35, when the infection prevailed on the right side, the right lobe was more enlarged than the left, and in 10 with infection left-sided, enlargement of the left lobe was noted. S. R. Pietrowicz (*Jour. Amer. Med. Assoc.*, Jan. 8, 1916).

We can all go back to a number of these cases and find that we have overlooked focal infections, the alveolar abscess, the imbedded tonsils, the chronic appendicitis, the gall-bladder trouble, or a chronic cystitis. J. A. McDonald (*Miss. Valley Med. Jour.*, Sept., 1918).

In a case observed by the writer, the symptoms of exophthalmic goiter improved after extirpation of a uterine fibroma plus uterus and ovaries. O. Khoór (*Zentralbl. f. Gynäk.*, Feb. 6, 1926).

The neurogenic theory, held by Oswald, Marañon and others, in which it is believed that the genetic factor lies in the nervous system and that a predisposition to the disease is imperative, is supported by numerous cases resulting from the harrowing incidents on the firing lines in the World War.

My theory, which I have termed the neuro-endocrine theory, has much in common with the foregoing and with the neuro-thyroid-adrenal theory of Sajous. The neuro-endocrine theory is a combination or merging of the most plausible views on the etiology of the disease, based upon my opinion that Graves's disease is

a generalized dysfunction of the vegetative nervous system and of the entire chain of endocrine organs. According to this theory the patient has an inherited, rarely an acquired, neuro-endocrinopathy serving as the predisposing factor; it requires but the torch of an exciting cause, usually an emotional strain, a psychic trauma, or an intoxication, to bring on the conflagration of Graves's disease.

Among other theories may be mentioned the parathyroid theory of Gley; the adrenal theory held by Swiecicki and implied by Cannon and Crile; the sympathetic theory held by Koeben, Aran, Trousseau and Charcot, in which the sympathetic nervous system is held responsible for Graves's disease; the thyroid insufficiency theory of Gauthier; the vagotonia and sympathicotonia theory of Eppinger and Hess; and the dysthyroidism theory which has Janney as its greatest proponent.

**Primary Cause.**—The majority of investigators are of the opinion that infectious foci, if not the exciting cause, at least aggravate the syndrome by their presence. Infected teeth, tonsils, sinuses, intestinal auto-intoxication, diseases of the biliary tract and of the uterus and adnexa, are very commonly encountered in Graves's disease, as stated above. While it cannot be said that the coexistence of one of these conditions is tantamount to an etiological relationship, it can be said that in a goodly percentage of subjects of Graves's disease the removal of infectious foci is an important step in therapeutics. Such general infections as acute rheumatic fever, tuberculosis, syphilis, typhoid fever, pneu-

monia, and other toxemias of bacterial nature are likewise of etiologic importance.

Pregnancy and childbirth are not provocative of as many instances of Graves's disease as is claimed by some observers. Simple goiter may develop at this time in response to physiological demands made upon the thyroid, but Graves's disease rarely is produced by pregnancy or childbirth. I find, however, that in the event of pregnancy *during* the course of Graves's disease (again a rare occurrence) the syndrome usually is aggravated, and there is commonly an occurrence of spontaneous abortion. In the occasional instance in which the fetus goes to term, the infant usually is normal, but once in a great while it may present a *simple* goiter. Very rarely the infant may present evidences of exophthalmic goiter.

In 1586 pregnancies the writer noted 132 goiters, only 8 of which were toxic or of the hyperthyroid types. In 28 years he has had under supervision 100,000 cases and had never heard of operative interference for hyperthyroidism, except in 1 case, in which he operated personally. The woman was expecting her ninth child. She had previously had the right lobe of the thyroid removed. During this pregnancy she was really suffering from pressure of bands across the trachea. The left lobe of the thyroid was removed, with complete relief of symptoms. The writer does not think pregnancy increases the symptoms of simple thyroidism. The hygienic surroundings and treatment of the patient play a large part. J. W. Markoe (Trans. Amer. Med. Assoc.; Med. Rec., June 22, 1918).

In a case recorded by the writer premature delivery occurred, without mishap except a tardy secondary hemorrhage. The fetus was apparently normal, but the gestation had an

aggravating influence on the exophthalmic goiter. Severe arrhythmia developed and proved fatal the fourth day after delivery. Alfaro (Revista de Med. y Cir., Jan., 1925).

Traumata, especially (as Putnam suggests) blows on the head and injuries to the thyroid itself, may be the exciting factor of Graves's disease in predisposed subjects. The popularity of speeding automobiles has added greatly to the list of cases. Shipwrecks, earthquakes, conflagrations, express train collisions, war conditions, and many other conceivable states in which the instinct of self-preservation is brought to the fore, or where one must immediately decide between fight or flight, are very potent exciting causes of Graves's disease.

Finally, the ingestion of iodine or of thyroid extract by individuals susceptible to Graves's disease may serve as the exciting cause of the affection. The recent widespread tendency to drugging with iodine in the prevention and cure of goiter has become a genuine menace to the community at large. Quite a few instances of Graves's disease have come to my attention as the result of indiscriminate iodine administration. The same may be said of the recent increase in self-drugging by thyroid extract, because of the many thyroid-containing preparations on the market which are advocated for the treatment of obesity.

**PATHOLOGY.**—The pathology of the thyroid gland in Graves's disease is essentially that of hyperplasia. Macroscopically, there is usually an increase in the size of the organ which may vary from a slight swelling to twice or many times the

normal thyroid. Many instances are encountered in which the thyroid is not at all enlarged and rarely the organ is even a trifle smaller than usual. The average specimen from a case of Graves's disease presents an equal enlargement of all its parts. The surface is smooth, but a cut section presents a homogeneous structure not seen in ordinary parenchymatous goiter, with little or no visible colloid. There is an increase in the number and size of the blood-vessels. Microscopically, there is an infolding and crowding of the cells upon the acinar spaces; an increase in the number and size of the cells; an increase in the number of alveoli; and a diminution in alveolar colloid and its contained iodine. The specimen presents a picture of glandular hyperactivity with the exception that the products of secretion are diminished or absent, having passed into the circulation as soon as manufactured.

Atypical specimens are often encountered. For example, hyperplasia may not be diffusely distributed, but there may be a patch of it surrounded by non-hyperplastic structures. One or more cysts or areas essentially adenomatous or even fibrous may be found. In a truly hyperplastic thyroid, carcinomatous changes are extremely rare.

Graves's disease may be associated with a purely non-hyperplastic goiter, without any necessary etiological relationship between the mass and the syndrome, thus rendering diagnosis difficult. If an individual without a previous goiter can develop Graves's disease, why cannot a subject already possessing a simple goiter develop the syndrome? The mass will

be found to lack the hyperplastic pathology, but the patient's thyroid behind the adenoma will be discovered to present pathological characteristics.

Areas of degeneration dominating the pathological picture may be observed in patients whose symptomatology has become changed, presenting clinical evidences of myxedema. These changes, when occurring slowly, may give rise to a picture of apparent cure of the patient.

In the majority of cases there is a persistently enlarged thymus gland. The percentage of such instances varies widely with the experience of different observers. Kocher found enlarged thymus in nearly 50 per cent. of his cases; Capelle in 95 per cent. of his fatal cases; Blackford, in a study of 74 autopsies, found that in all subjects under 40 years there was a persistent thymus.

The spleen and lymphatics often seem to participate in the pathology of Graves's disease. There is a tendency toward generalized lymphatic hyperplasia, usually of moderate degree.

Anemia is not characteristic of the syndrome. Though the patient presents the typical flushed appearance dependent upon peripheral vasomotor instability, the usual red blood count is 4,000,000 or more per cubic mm. Kocher has long ago called attention to the constancy of leucopenia of varying degree, associated with a relative lymphocytosis. Thus, the leucocytes may be reduced to 6000 or less with a 50 per cent. diminution of polymorphoneutrophils.

The writer observed a marked phagocytosis of the actively working thyroid cells themselves, a fact appar-

ently overlooked so far. Only those thyroid acini undergo phagocytosis which are newly differentiated and are at a special stage of functional overactivity. Goormaghtigh (*Endocrinology*, May, 1924).

Diminished fibrinogen and calcium content with Graves's disease are characteristic, resulting in a diminution of coagulability of the blood.

Of the pathology of the nervous system in Graves's disease little can be said. Wilson found hemorrhages and areas of softening in the brain and the medulla, with occasional atrophy and sclerosis of the restiform bodies. The cervical sympathetic may present hyperchromatization, chromatolysis, atrophy, and granular degeneration of the nerve cells and nerve fibers. In the average case, however, the brain, spinal cord, and sympathetic system present no definite alterations.

The pathology of the heart and blood-vessels is important. Cardiac hypertrophy, dilation, or both, are quite common in Graves's disease, and are frequently the cause of death. Fahr describes chronic interstitial inflammation in the myocardium, with collections of round cells, chiefly lymphocytes, among the muscle fibers and in the neighborhood of the blood-vessels. The muscle fibers are apt to be separated from one another and show such degenerative changes as fragmentation, dissolution, and occasionally fatty degeneration. Hashimoto was able to confirm Fahr's findings. Goodpasture describes acute necrosis of the cardiac muscle, in one instance so diffuse as to involve a large part of the left ventricular wall. The blood-vessels, especially the aorta and large vessels issuing from it, are likewise capable of un-

due distension with thickening and degeneration of their walls.

The pathology of the other organs need not detain us, as it is not characteristic. Friedman discovered chromophilia of the anterior lobe of the pituitary gland, with an increase in the number of basophiles. Rautman has found some atrophy of the adrenals, while Pettevel, Wiesel, and Hedinger (quoted by Roussy), discovered a diminution in the medullary substance of the suprarenals in Graves's disease with status lymphaticus. The pancreas has been found to participate in many instances: Holst, for instance, observed degenerative processes in the islands of Langerhans in 4 cases. The orbits in instances of marked exophthalmos may show an excessive amount of retro-orbital fat, as in a case reported by Mackinnon. The ovaries, liver, and kidneys are apt to be found in varying states of degeneration. Kerr and Rusk report a case of acute yellow atrophy of the liver associated with Graves's disease. Hyperplasia of the salivary glands is occasionally observed.

**PROGNOSIS.**—There is an acute or abortive type of Graves's disease which fortunately is rare. The course is brief and malignant, associated with rapid loss in weight, extreme tachycardia, hypertension, various forms of arrhythmia, incessant nausea, vomiting, diarrhea, and often hyperpyrexia. Exophthalmos is marked, and trembling is so severe as to cause vibration of the bed upon which the patient lies. There may be loss of one-half the body weight within a few weeks. It is evident that the prognosis in a case of this sort is grave. Mental derangement,

such as acute delirium or dementia, may lead to death from exhaustion within several weeks.

An acute exacerbation may follow thyroidectomy and is often styled "acute hyperthyroidism," a common cause of post-operative death. Crile, Crotti, Chesky, Major, and others have attributed this status to acidosis. Sajous does not recognize the so-called "acute hyperthyroidism" theory, and attributes the danger signals to heart failure. He has saved life by injections of adrenalin in such cases.

An acute exacerbation may occur during the course of the disease from an added psychic trauma. Thus, a patient of mine, progressing nicely, developed a severe relapse because of the shock incident to the bursting of a large auto-truck tire outside her bedroom window while she was asleep. In another case, that of a young woman, an exacerbation was brought on when she was badly frightened by a lightning storm.

The course and prognosis of the average case of Graves's disease depends upon such circumstances as the age, sex, previous condition of the patient, the severity and duration of the syndrome, the presence or absence of complications, and the mode of treatment, if any, that is adopted. Spontaneous recovery occurs in so few instances that to expect this is to deprive the patient of a fair chance for health.

Accurate figures in a discussion of the prognosis of Graves's disease are not obtainable, since this should include observation of circumstances beyond our control. Improper diagnosis and treatment and unreliable statistics, based more upon *operative*

than *clinical* recovery, are the main difficulties in the formation of prognostic generalizations. McCarrison states that death usually occurs from 6 months to 6 years after the onset of the malady. In over 50 per cent. of cases death occurred within 18 months. Blackford states that in 50 per cent. of his 74 necropsies, 50 per cent. of deaths occurred during the ninth month of the disease, the remainder after the twelfth year. It is, therefore, evident that the first 12 months of the disease is the period of greatest peril.

The younger the sufferer, the more severe the syndrome, but the prognosis is not graver in the same degree. In the male, the course of the disease is apt to assume a more rapid and severe character than in the female.

The mode of treatment instituted plays an important part in the prognosis of Graves's disease. There are two main schools of treatment, surgical and non-surgical, roentgenotherapy occupying a place somewhere between the two. In common with Sajous, Solomon Solis-Cohen, Marañon, and a large number of other observers, I firmly believe that the surgical mortality rate associated with thyroidectomy is much higher than commonly stated. The term "cure" is often applied to mere improvement which is usually short-lived and followed by a return of the former clinical picture, including goiter. Surgical patients are not generally followed up in person for the number of years required really to determine whether recovery is complete and permanent. The general practitioner, therefore, is to a large extent responsible for the prognosis of his patient,



depending upon the method of treatment into which he steers his charge.

The mortality rate in the writer's series of 100 operated cases was 11 per cent. Exclusive of 4 deaths directly due to surgery, the mortality rate was 7.3 per cent. Deducting 3 accidental deaths, it was 4.3 per cent. Cure was obtained in 38 per cent.; about 21 per cent. were sufficiently improved as to be restored to full social and economic usefulness. The remaining 30 per cent., which includes 23 of 25 patients previously operated, are deemed sufferers from the disease or its sequelæ the remainder of their lives. Read (Amer. Jour. Med. Sci., Feb., 1926).

**TREATMENT.**—Toxic adenoma, simulating Graves's disease, and synonymous with hyperthyroidism, is strictly to be differentiated from Graves's disease, and is not here under discussion. It is considered at length in an earlier article under Goiter and Toxic Goiter.

Each case of Graves's disease is to be treated on its own merits, as individualization is the keynote to success. The first principle underlying a rational régime of treatment is an attempt at elimination of all discoverable exciting causes, *especially infectious foci* and irritating physical and mental environmental conditions. Next in importance is the administration of remedies calculated to overcome the subjective and objective symptomatology. Since in these patients the mind is quite as sick as the body, the patient himself requires quite as much individual attention as the disease. Hence, no matter what is discovered to be the best remedy or remedies in a given case, properly applied psychotherapy plays a vital rôle. The physician should succeed in obtaining the necessary co-operation on the part of the pa-

tient and household in the carrying out of therapeutic instructions.

**Rest.**—Absolute rest in bed without respite is an erroneous procedure in the average patient, as this leads to introspection and aggravation of the syndrome. Unless there is marked cardiac damage with leaking valves, the patient may be permitted out of bed four hours in the morning and four hours in the afternoon. These periods make for greater self-confidence and enable the patient to enjoy the social intercourse necessary to contentment. Moreover, the hours out of bed may be spent in relaxing conversation, listening to music, the radio, the reading of light literature, and even an occasional attendance at a theatre.

If the household is not tranquil but is a place of strife and discord, the patient's abode had better be changed. This is often a difficult problem to solve, for as a general rule the hospital is not satisfactory; the usual country place does not offer the necessary conveniences for proper rest and food; the seashore usually aggravates the condition, and the sanitarium is often a place where the inmates are more or less mentally deranged or incurable. Patients with Graves's disease must be placed in an environment where the contagion of geniality and health is constant; where mental adjustment is possible through an atmosphere and contact that are unmistakably sane, sincere and sympathetic. If the household can really be brought under the sway of the understanding psychotherapist and be so modified as to assist rather than hinder progress, the patient had best stay at home. Otherwise, it is best to seek and find some acceptable

country place or even a sanitarium possessing the necessary qualifications. Where a choice is possible, the location had best be away from the shore, at moderate altitude, with an equable climate.

The fundamental importance of rest in the treatment is well shown in a series of 38 cases reported by the writers. All the patients were simply placed in hospital wards under conditions as ideal as possible, and received no specific treatment. The effects on the basal metabolism were closely watched for periods as long as 15 months. A sharp decrease of the rate usually took place after a short time in the hospital, and the general tendency to decrease was more marked than in a series previously treated by Means and Aub with the X-rays. Furthermore, comparing the effects with those in a series of cases subjected to thyroidectomy, it was noticed that after the fourth month the basal metabolism of all but 3 patients was below the average figure for the thyroidectomized group at the end of 15 months. Kessel, Lieb and Hyman (*Jour. Amer. Med. Assoc.*, Oct. 7, 1922).

**Diet.**—It must be recalled that the patient is burning up a great quantity of the food intake and that he is usually emaciated. Hence he requires not only enough food to counteract the excessive catabolic influences but also a sufficient amount to enable the body tissues to restore themselves to normal. Boothby and Sandiford, in a quantitative study of the food intake and urinary elimination, blood chemistry, and the respiratory metabolism, found the total metabolism to be frequently in excess of 5000 and occasionally 6000 calories daily.

In order to maintain body weight while resting in bed, the food intake in a patient with exophthalmic goiter and

an elevated metabolism must be at least from 75 to 100 per cent. greater than the basal metabolism. A study of the histories of 65 patients with exophthalmic goiter indicated that although 88.5 per cent. of them had an appetite which was classified as ravenous, increased or normal, yet 86.5 per cent. of these patients gave a history of a loss of 11.9 kg. (26¼ pounds) of body weight in 11.9 months. A comparison of the body weight of these 65 patients with the standard weight tables shows that 80.2 per cent. averaged 18.2 per cent. below normal when they first appeared at the hospital. Sturgis and Green (*Arch. of Intern. Med.*, Oct., 1925).

Flesh foods had better be reduced to a minimum. Three very ample meals daily, six hours apart, consisting essentially of bread, the various cereals, dairy products, fruit, vegetables, and the like, with three extra nourishments between meals, should constitute the dietary. An occasional small portion of fowl or fish (three or four times a week) may assist some patients in overcoming a possible monotony of diet. Tea, coffee and other stimulants, spices and condiments are strictly forbidden. Digestive disturbances must be promptly overcome, as a good digestion is a valuable asset in progress. In a patient with an excellent digestive tract, able to undergo a process of forced feeding, little difficulty should be experienced in the restoration of weight, with concomitant reduction in pulse rate and improvement in subjective and objective symptomatology.

**Drugs.**—The selection of a drug or drugs in the management of Graves's disease is to be decided upon with due consideration for the idiosyncrasies of the patient. Here too, individualization must be exercised.

Constipation or fecal retention must be overcome by **saline enemas** or by **oil injections**. **Sodium phosphate** is perhaps the best remedy to be administered internally in the interests of intestinal hygiene.

Often the reverse is the case, the patient being drained of strength and discouraged in spirits because of intractable diarrhea. The administration of **atropine** in  $\frac{1}{150}$  grain doses, 2 or 3 times a day, may be of use, and will not increase the heart rapidity, but rather, as McGuigan has pointed out, tend to lower the heart rate. Astringents such as **tannigen** (Merck), **bismuth subnitrate** or **subgallate** may likewise be of service.

**Organotherapy** holds an important position in the medicinal treatment of Graves's disease. Though thyroid extract may in rare cases (in which myxedema dominates the symptomatology) seem to improve the clinical picture, it must otherwise *never* be employed. Thymus gland, though reported of distinct use by Owen, Mikulicz, Blondel, and others, is of doubtful value. I have tried it out in a series of cases, and conclude with Pisani that this substance is not only useless but is often contraindicated. Parathyroid extract, though harmless, is of doubtful value in overcoming tremor.

The most useful endocrine products in Graves's disease are pituitary substance, suprarenal gland, ovarian extract (or corpus luteum) and pancreatin. **Posterior pituitary** has been found of distinct service by Solomon Solis-Cohen, Hector Mackenzie, Barr, and others. It may be administered in doses of  $\frac{1}{4}$  to 1 grain, 2 or 3 times a day by mouth, or 5 to 20 minims hypodermatically, once, twice or

thrice daily. During threatened or actual circulatory decompensation in late Graves's disease, the hypodermic injection of posterior pituitary is most serviceable. **Suprarenal gland**, in doses of 2 to 5 grains, 2 or 3 times a day, is very useful in many instances. I have been able amply to confirm the reports by Shapiro and Marine regarding the efficacy of **suprarenal cortex**.

Rapid and striking improvement in the general nutrition was observed by the writers in a case of exophthalmic goiter following administration of **fresh ox suprarenal cortex**. It may be given in 5 Gm. (75 grain) doses daily by mouth without untoward effects. Improvement on the desiccated gland was less marked. They state evidence is accumulating to the effect that the suprarenal gland, particularly its cortex, plays an essential rôle in exophthalmic goiter. Shapiro and Marine (Endocrinol., Nov., 1921).

**Ovarian extract** and **corpus luteum** would seem to be of distinct value when we recall that there is gonadal deficiency in Graves's disease; Coulaud, Hoppe and others are very enthusiastic over the results obtained with these substances. **Pancreatic extract** may be found of service when there is obvious deficiency of starch digestion. In this connection we are not surprised to learn that **insulin** is gradually occupying an important place in the treatment of Graves's disease. Lépine and Parturier, Lawrence, Goffin, Senga, Puchulu and Richter have already reported good results in the management of these patients with insulin.

**Serum therapy**, though occasionally apparently useful, is generally of doubtful value. Rogers and Beebe's serum, prepared by injecting rabbits with a serum from hyperplastic thyr-

oids obtained from Graves's disease patients, is stated by Forchheimer to have no reason for existence and should never be used. **Thyroidin** or **antithyroidin**, prepared from the serum of sheep deprived of the thyroid gland 6 weeks before the first serum is taken, has been found of service in a percentage of instances. It may be given in doses of 10 to 30 minims 2 or 3 times a day. **Thyroidectin**, obtained from the blood of thyroidectomized sheep, is administered in powder form in capsule in doses of 5 to 10 grains 2 or 3 times daily. Coulaud and Loughnon, in a recent study, concluded that the use of serum from thyroidectomized sheep is of doubtful value, and that the presence of antithyroid substances in the blood of thyroidectomized animals is dubious. In this variety of remedies may also be classed rodagen, the dried milk from thyroidectomized goats, introduced by Lanz.

Quinine has a distinct field of usefulness in the average case of Graves's disease. **Quinine hydrobromide** (or hydrobromate) was brought to the attention of the profession by Forchheimer about 40 years ago. It is administered in capsule form, from 15 to 40 grains daily, until the limit of tolerance is reached, when the dosage is adapted to individual requirements. Forchheimer's original prescription called for a 5-grain capsule combined with one grain of ergotin, 3 or 4 times a day. Quinine sulphate and other quinine salts may likewise be used, with practically similar results. **Quinidine sulphate**, highly extolled in auricular fibrillation, may also be used in Graves's disease in doses similar to quinine hydrobro-

mide. I have employed it in a number of instances of auricular fibrillation in Graves's disease and found it of scarcely any more value than other quinine salts.

**Arsenic**, regarded as capable of depressing thyroid secretion, may be given in the form of the **trioxide** in doses of  $\frac{1}{100}$  to  $\frac{1}{30}$  grain in combination with other drugs. I have found the **arsenate of iron** useful in doses of  $\frac{1}{16}$  to  $\frac{1}{10}$  grain. Putnam well states that in the event of extreme irritability of the stomach with intolerance to arsenical products, subcutaneous injections of the **cacodylates** may be of use. Despite Mendel's asserted good results from the use of a combination of arsenic and iodine intravenously, this combination, especially intravenously, is to be employed with extreme caution.

Simonton, Roorda-Smit, Schulman and others have reported cures of Graves's disease by **arsphenamin** with or without the old-fashioned mixed treatment of **iodides and mercury**. Antisyphilitic treatment is useful in those instances in which there is reason to believe that the etiology is of luetic origin. Graves's disease is, however, not commonly seen in syphilitic patients, though occasionally the clinician is apt to obtain good results from antisyphilitic treatment in patients who present no evidences of syphilis.

**Sodium salicylate**, advocated by Babinski, Anders and others, has both theoretical and practical value, serving to counteract possible rheumatic infections which may bear an etiological relationship to the disease. It is likewise an intestinal antiseptic, and is a drug which tends to lessen the heart rate.

Intestinal antiseptics, such as **phenyl salicylate**, **methenamin**, **thymol**, **menthol**, **betanaphthol** and the like, are advocated by McCarrison, who believes that a large percentage of cases of goiter, with or without the presence of Graves's disease, result from intestinal toxemia.

**Belladonna**, **atropine** and **hyoscyamus** have a limited usefulness in Graves's disease. When tremor is exceedingly marked, and more especially if there be excessive sweating or bladder irritability, these substances may be administered with due caution.

**Calcium** is indicated, since there is a deficiency of blood calcium with diminished coagulability of the blood in Graves's disease. **Calcium glycerophosphate** is especially useful, alone or combined with other medications.

**Lecithin** was pointed out by Berkeley in 1908 as very useful. It may be administered in alcoholic solutions, or preferably in solid form, each dose corresponding to  $\frac{1}{100}$  grain of organic phosphorus.

**Iron** may be administered in cases of tangible secondary anemia. It is also of value in controlling mild diarrhea. As already stated, it may be administered in the form of arsenate of iron.

**Ichthyol** has in my experience proved of valuable service in Graves's disease. It overcomes anorexia and with **quinine** constitutes an excellent formula for the control of the patient's symptomatology. The distasteful eructations following the use of ichthyol taken internally can be overcome by beginning with minute doses;  $\frac{1}{4}$  grain in combination with other drugs *t.i.d.* may gradually be

increased to 1 grain, or to 2 grains, without complaint.

**Eserine** or **physostigmine** has been advocated by Moutier and Lian and Welti for the tachycardia and palpitation of Graves's disease. While eserine is of service in patients presenting marked sympatheticotonia with gastric discomfort, nausea and constipation, I find it incapable of reducing the heart rate to any considerable extent.

**Iodine** is a useful drug in a minority of instances. Its effects must be watched closely, else irreparable harm may be wrought. Recently there has been much written on the use of **iodine**, especially **Lugol's solution**, in Graves's disease as a *preoperative measure*. Nearly all of these observers, however, agree that whatever benefit is derived from its use does not continue after a certain point is reached. The body having received as much iodine as it cares to take, soon becomes poisoned by the drug, and the patient becomes worse.

The writer resorts to **iodine** therapy on the basis of the following hypothesis: Exophthalmic goiter is due to excessive stimulation of the thyroid. Iodine treatment does not act when the thyroid secretion itself is normal, and even compound solution of iodine will show no effect. Stimulation of the gland will change the picture and the above solution will do so. Even toxic adenoma cases gave good results. Digitalis is deemed dangerous and should be avoided. When there is generalized edema and broken compensation, he gives iodine. It has a marked influence on the latent infection. Plummer (Trans. Assoc. Amer. Phys.; Jour. Amer. Med. Assoc., May 24, 1924).

In most cases of exophthalmic goiter the writers found that administration of iodine by mouth caused a

remission as rapid and as extensive as that following subtotal thyroidectomy, but that it was not sufficient to suppress the disease permanently. After such a patient has been taking iodine for a while, a rapid rise in the metabolic rate and an increase in the toxic symptoms occurred within 1 to 2 weeks. Starr, Walcott and Means (Arch. of Int. Med., Sept., 1924).

**Iodine** is especially *harmful* in cases *where the goiter is exceptionally large* or where there is an adenomatous admixture within the thyroid. Within the past 15 months, I have seen 4 cases in which iodine employed in the presence of large hyperplastic goiters caused the mass to become so greatly increased in size as to provoke dangerous pressure symptoms with need for an emergency thyroidectomy to save the patient's life. It is of utmost importance that the drug (whether in the form of Lugol's solution, the tincture, or sodium or potassium iodide) should be promptly discontinued when it is discovered that its efficacy is doubtful, for, as Sajous aptly states, "Iodine is a two-edged sword with its sharpest edge menacingly turned toward the patient at every turn." In a goodly percentage of patients iodine is responsible for the precipitation of a dangerous crisis.

The method is fraught with danger. According to the writer, a great deal of damage will be done with iodine in thyroid cases if we get too enthusiastic. His results in the Massachusetts General and Peter Bent Brigham Hospitals showed that iodine is very valuable as a preparation for operations because it controls the situation *temporarily* in certain cases. The control is limited, and continuation of treatment in a large percentage of cases seems to result in complete loss of benefit from the iodine. If it is discontinued after a considerable period of time,

there is a marked increase in symptoms to a point which is much more marked than that which existed prior to the iodine therapy, and, consequently, there is considerable danger in connection with operations after long use of iodine. Another source of trouble is that the patient is apt to go home and continue taking iodine. Mason's method of treatment may prevent trouble, but we should recognize that there is still a lot we do not know about the thyroid in relation to iodine and as clinicians we may cause harm in the course of acquiring knowledge. H. A. Christian (Trans. Assoc. Amer. Phys.; Jour. Amer. Med. Assoc., May 24, 1924).

Iodine should not be used when the basal metabolism is above normal, *i.e.*, in true hyperthyroidism. Allusion to a case in which iodine given by the family physician caused the basal metabolism to rise 5.5 per cent. per week, with toxic symptoms steadily developing. In another instance, the patient was about to be given iodine when a precautionary basal metabolism test showed +54. The cause of the overactivity of the thyroid is as a rule a focal infection, which should be eliminated to cure the case; iodine is active only insofar as it activates for a time the defensive function. The writer agrees with Bram that individualization is the basis upon which successful treatment depends. A most painstaking physical examination, with the necessary laboratory analyses, is required. The diet should be ample, but exclude flesh, stimulants and irritants. Sajous (Jour. Amer. Med. Assoc., Nov. 8, 1924).

**Digitalis** must be employed in the event of impending or existing circulatory decompensation, not necessarily in the treatment of the Graves's syndrome. Under these circumstances, the hypodermic or intramuscular injection of digitalin or some other digitalis product is of service. This may be combined or alternated with

injections of **posterior pituitary**. Digitalis, often resorted to as a routine for tachycardia, is practically useless during the *active* stage of Graves's disease. It not only fails to influence favorably the rapidity of the heart's action, but aggravates conditions by interfering with the digestive functions which, in turn, may reflexly *increase* the heart's rapidity. On the other hand, during a remission, digitalis may serve to establish a normal heart rate, especially if the patient is under a broad régime of therapeutic attention. The most satisfactory use of digitalis is seen during convalescence when all other evidences of the disease are disappearing. When, for example, the basal metabolism is not above + 15, the patient has gained nicely in weight, and the thyroid, eyes, and nervous system have reached an almost normal status, the heart, if still rapid, will in the majority of cases respond promptly to gradually increasing doses of digitalis. The same may be said of **digalen**, **digitalin**, **digitan**, and other digitalis products.

What has been said above applies equally as well to other heart drugs such as **sparteine sulphate** and **strophanthus**.

**Bromides**, **sulphonal**, **trional**, **paraldehyde**, and **hyoscine hydrobromide** may be used with discretion in efforts at quieting the nervous symptoms. Due care must be exercised in the selection of drugs of this nature, especially of coal tar products.

**Barbital** and **luminal** are, in my experience, the most satisfactory sedatives to be employed in the control of the nervous manifestations of Graves's disease. They may be given in fractional doses *t.i.d.*, combined with other

medicaments, or in a single dose an hour before bedtime. The dosage varies with the degree of nervousness and insomnia on the one hand, and susceptibility of the patient on the other. Barbital should not be given in excess of 9 or 10 grains daily, and luminal not in excess of 4 grains daily. Following improvement in sleep and nervous symptoms, these substances must be gradually reduced in dosage until they can safely be discontinued.

*Local measures* directed to the thyroid should receive mention in consideration of the treatment of Graves's disease. In the presence of an unusually large, throbbing hyperplastic thyroid, with the patient in bed much of the time, the application of an **ice-bag** over the goiter 6 or 8 hours daily, divided off into periods of an hour or two each, may assist in the relief of excessive vascularization of the organ.

**Quinine and urea** injections into the thyroid gland, as advocated by Watson, must be employed with extreme caution if at all. Watson claims that their greatest field of usefulness is in beginning hyperthyroidism not severe enough to justify operation, or as a preparatory measure to partial thyroidectomy.

**Boiling water injections**, advocated by Porter and later by a number of other observers, constitute a procedure not devoid of danger. This, too, is a measure occasionally employed pre-operatively.

Injections into the goiter of iodine, phenol, alcohol, and other substances, have been advocated from time to time, but are not devoid of danger.

**X-ray** treatment occupies first place in the consideration of elec-

tricity in the treatment of Graves's disease. The bibliography of roentgenotherapy in Graves's disease is large, featuring such names as Beck, Williams, Pusey, Stegman and Görl, Pfahler, Secher, Florence Stoney, Seymour, Holmes, Schlecht, Allison, Bear and McKinley, Bécère, Belot, Means and Holmes, and many others. Roentgenologists claim, in support of their mode of treatment, that this procedure is bloodless, painless, devoid of inconvenience to the patient, is not associated with shock, does not produce scars, is devoid of a mortality rate, is not associated with the accidents to which surgery is susceptible, and yields a larger percentage of good results than surgery. Surgeons, on the other hand, claim that roentgenotherapy is not as efficient in the production of results as is surgery, precise dosage is impossible, it frequently results in myxedema, acute exacerbations of hyperthyroidism, and occasionally in sudden death; it gives rise to such accidents as burns, keloid, cancer of the neck, atrophy of the skin and telangiectasis, it renders surgery more difficult because of adhesions occurring within the goiter, and when benefit by X-rays is obtained it occurs too slowly. The open-minded student of Graves's disease cannot help but feel that surgery and roentgenotherapy have one thing in common, namely, the reduction of the structure and function of the thyroid gland—the former with the knife, the latter bloodlessly.

The internist realizes that the *rationale* of both surgery and roentgenotherapy depends upon the theory that Graves's disease is a pure hyperthyroidism. That the disease is *not* a pure hyperthyroid-

ism, but a widespread affection, the predisposition to which is probably congenital, is the current consensus of opinion based upon physiological, pathological, clinical, and therapeutic evidences. A mere cutting off of a portion of the thyroid gland, surgically or otherwise, is hardly capable of resulting in complete, permanent cure of the affection. Local approach with the purpose of destroying a portion of the thyroid appears the rational procedure only in that small percentage of cases in which the thyroid is so active as practically to run away with the patient, or in those instances in which the goiter produces dangerous pressure symptoms, especially when intrathoracically located. Even under these conditions surgery or X-ray, as the case may be, should be employed as a *mere constituent* of a broad régime of non-operative therapeutics.

**Radium** has been used by Aikens, Turner, Mowers, Loucks, Terry, Hagans, and others, with the same purpose in view as when X-rays are employed. The asserted success of this mode of treatment is still to be confirmed by further observation.

**Galvanism** applied over the thyroid gland and the sympathetic ganglia may be found useful in selected cases. Schvostek, Foubert, and others speak highly of this form of electricity, and I, too, have found it useful in a percentage of instances. Weak currents and daily or bi-daily sittings are advised. Hase reports good results from the use of the **faradic current** applied over the thyroid in mild and moderately advanced cases of Graves's disease. Static electricity applied in the form of the **static wave current** was advocated in 1908 by



Snow as highly useful in the local treatment of the hyperplastic thyroid of Graves's disease. When care is taken not to cause discomfort, this measure may be employed during 10 minute periods given 3 or 4 times a week.

In summarizing my remarks on the treatment of Graves's disease, I must emphasize that individualization must be the dominating factor. The disease presents many and varied types; the patient himself may differ from all others in inherent peculiarities and idiosyncrasies, so that in the consideration of remedies, "what is one man's meat is another man's poison."

Presented with a patient suffering with Graves's disease, the first duty of the medical attendant is to take a careful history and make an extended physical examination, supplemented by laboratory procedures, with a view to eliminating all discoverable etiological factors. Secondly remedies must be employed with a view to combating the symptoms presented by the patient.

Finally, it must be emphasized that in no other disease in the domain of medicine is **psychotherapy** more useful than in Graves's disease. The medical attendant must learn virtually to understand and speak the language of the patient and have control not only over him, but likewise over all those closely concerned in his welfare. In the presence of faithful co-operation on the part of the patient and household, the well equipped internist employing properly selected prophylactic, hygienic, dietetic, medicinal, psychotherapeutic, and, if indicated, electrotherapeutic measures, should succeed

in effecting complete, permanent recovery within 8 to 12 months.

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**GRINDELIA.**—Grindelia is the leaves and flowering tops of *Grindelia camporum*, *Grindelia cuneifolia*, or *Grindelia squarrosa*, which are herbaceous perennial plants indigenous to Mexico and the Pacific coast of the United States. They contain a resin, a volatile oil, and an alkaloid (grindeline).

**PREPARATIONS AND DOSES.**—*Grindelia* (leaves and tops), N. F.,  $\frac{1}{4}$  to 1 dram (1 to 4 Gm.).

*Fluidextractum grindeliae*, N. F. (fluidextract of grindelia),  $\frac{1}{4}$  to 1 dram (1 to 4 c.c.).

**PHYSIOLOGICAL ACTION.**—Grindelia has an acrid, bitter taste. When chewed it excites the secretion of saliva.

The drug is an antispasmodic, motor depressant, and has slight expectorant and diuretic effects.

It slows the heart and increases the blood-pressure. It stimulates the bronchial membrane and the kidneys, and is eliminated by them.

When given in large doses, grindelia induces paralysis of the peripheral sensory nerves, the sensory centers in the spinal cord, and later the motor centers and nerve-trunks; the pupils become dilated and renal irritation is produced.

**THERAPEUTICS.**—**Spasmodic asthma** and **bronchitic dyspnea** may be relieved by the fluidextract of grindelia in doses of  $\frac{1}{4}$  to 1 fluidram (1 to 4 c.c.), every three or four hours, given preferably in a little sweetened water or milk. In recurrent asthma it often affords prompt relief, but it does not prevent the return of the paroxysms.

Grindelia has also seemed beneficial in **spasmodic coughs**, **pertussis**, **chronic bronchitis**, and in **hay fever**. The leaves of grindelia soaked in a solution of nitrate of potash and dried may be burned or smoked, and the fumes inhaled.

In **emphysema**, grindelia, according to Huchard, facilitates the respiration and expectoration. It relieves **pulmonary congestion** and the **palpitation** associated with

**cardiac hypertrophy, emphysema, asthma, and incipient tuberculosis.** The following formula is useful:—

- R.* Tincture of *grindelia* ..... 6 parts.  
 Tincture of *convallaria* ..... 2 parts.  
 Tincture of *squill* ..... 1 part.

Fifteen drops three times a day.

In **chronic cystitis** the drug gives relief by stimulating the mucous membrane of the bladder. The fluidextract diluted with water (1 to 10) is a serviceable lotion in **poison-oak** or **poison-ivy eruption**, and in **pruritic skin affections**. W.

**GUAIAIC.**—Guaiac-wood (*Guaiaci lignum*) is the heart-wood of *Guaiacum officinale* (*Lignum vita*). It is of olive, brown, or yellow color, very hard, and has a faint, aromatic odor and a pungent, acrid taste. The wood furnishes a resin, known as guaiac, which is brittle and breaks with a bright, lustrous fracture. Its odor and taste are the same as that of the wood. It is soluble in alcohol, ether, and alkaline solutions, but very slightly so in water. Guaiac resin is an ingredient of Plummer's pills (*pilula antimonii composita*).

#### PREPARATIONS AND DOSES.—

The following preparations are recognized in the National Formulary:—

*Guaiacum*, N. F. (resin of guaiac); dose, 10 to 30 grains (0.6 to 2 Gm.).

*Tinctura guaiaci*, N. F. (tincture of guaiac); dose,  $\frac{1}{2}$  to 1 dram (2 to 4 c.c.).

*Tinctura guaiaci ammoniata*, N. F. (ammoniated tincture of guaiac); dose,  $\frac{1}{2}$  dram (2 c.c.).

**PHYSIOLOGICAL ACTION.**—Guaiac taken internally causes a sense of warmth in the stomach, and increases the secretion of the digestive fluids. In large doses it gives rise to gastrointestinal irritation and produces active purgation. A well-marked rash, attended with great itching and resembling that of copaiba, sometimes follows the use of guaiac.

The reaction of leucocytes to guaiac depends on the oxidizing effect of nucleoproteids in the pus-cells; possibly due to a fermentation which could not be separated from the other substances. The nucleoproteids of the liver, spleen, and thymus are all capable of breaking down

hydrogen peroxide, but do not turn guaiac tincture blue. Only one tissue of all those examined was able to produce the same reaction with guaiac as pus, namely, bone-marrow; leukemic blood, even in the smallest quantities, in marked cases turns guaiac tincture blue. Brandenburg (Münch. med. Woch., Feb. 6, 1900).

**THERAPEUTICS.**—Guaiac given early in a 30-grain (2 Gm.) dose, either in powder or in emulsion with white of egg, has been used to abort attacks of **acute tonsillitis** or of **acute pharyngitis**. **Rheumatism** of **subacute** or **chronic** type, and **rheumatic pharyngitis** may be relieved by the administration of either the tincture or the ammoniated tincture of guaiac; but, on account of its disagreeable character, other remedies are preferred.

Guaiac is employed in **gouty conditions**. According to Garrod it possesses the following advantages: (1) It is innocuous, and may be taken for an indefinite length of time. (2) It possesses considerable power, but less than colchicum, in directly relieving patients suffering from gouty inflammation of any part; it may be given whenever there is but little fever. (3) Taken in the intervals of gouty attacks, it has a considerable power of averting their occurrence; in fact, it is a very powerful prophylactic. (4) It does not seem to lose its prophylactic power by long-continued use. (5) There are a few patients who cannot continue its use. Guaiacum does not affect the formation of uric acid, but acts directly on the kidneys as a stimulant, enabling them to get rid of any accumulation in the tubules, thus preventing absorption from them into the blood.

**Amenorrhœa.**—In amenorrhœa not associated with anemia, the administration of 10 grains (0.6 Gm.) of guaiac, stirred in milk, before breakfast, has been credited with good results if continued for some weeks. **Painful menstruation** may be relieved by the ammoniated tincture in doses of  $\frac{1}{2}$  to 1 dram (2 to 4 c.c.) every two or three hours. W.

**GUAIACOL.**—Guaiacol (monomethylcatechol, methyl ether of pyrocatechin; methylpyrocatechin) is a

highly refractive, colorless, oily liquid, having a characteristic aromatic, agreeable odor, and is obtained by fractional distillation from beechwood creosote. It may also be obtained by the dry distillation of guaiacum, or produced synthetically by the action of methylsulphuric acid upon pyrocatechin. It is freely soluble in alcohol, ether, and carbon disulphide, and in 85 (Helbing) or 200 (Merck) parts of water. It also occurs in colorless crystals, which are freely soluble in glycerin, alcohol, ether, and slightly soluble in water. It forms salts with the acids; the carbonate and salicylate is a white, insipid, crystalline substance, with the odor of salol, and soluble in alcohol.

According to Winghoffer absolutely pure, crystalline guaiacol has little taste or smell. It can be obtained in an absolutely pure condition from a commercial sample by cooling with a mixture of ice and salt, and then separating the crystals which have formed.

#### PREPARATIONS AND DOSES.

—*Guaiacol*, U. S. P. (guaiacol—liquid), which contains 60 to 90 per cent. of creosote; dose, 2 minims (0.12 c.c.), gradually increased to 16 minims (1 c.c.).

*Guaiacolis carbonas*, U. S. P. (guaiacol carbonate); dose, 3 to 8 grains (0.2 to 0.5 Gm.), increased to 90 grains (6 Gm.).

Of the other preparations of guaiacol, such as the succinate, salicylate, benzoate, biniodide, etc., none has shown material superiority over the official product when pure.

#### PHYSIOLOGICAL ACTION.—

The physiological action of guaiacol is similar to that of its congener, creosote, although its effects on the

gastrointestinal tract are not so irritating. The respiration and pulse are only temporarily affected. The blood-pressure is slightly increased, and there is slight contraction of the arterioles. Large doses produce a burning sensation in the stomach, nausea, etc.: symptoms of gastrointestinal irritation. Guaiacol is excreted principally by the kidneys, as guaiacosulphuric ether, but also by the skin and the salivary glands, and in small measure by the lungs.

Guaiacol lowers the temperature when applied to the skin by influencing the peripheral ends of nerves, and through them, the thermogenic center. This influence of guaiacol is chiefly seen in febrile conditions.

After painting the skin with 2 Gm. (31 grains) of guaiacol, elimination by the kidney is manifested in a quarter of an hour. The proportion in the urine is greatest in from one and a half to four hours, and reaches 50 grains (3½ Gm.) per quart (1000 c.c.). It decreases rapidly in six or seven hours, and in twenty-four hours there is no further trace in the urine.

#### POISONING BY GUAIACOL.—

A case of poisoning, in a child 9 years of age, has been reported by Wyss, in which ¼ drams (5 Gm.) were accidentally taken. In a short time she became unconscious and cyanotic. The conjunctivæ became injected, the corneal reflexes diminished, and the pupil contracted and inactive. Vomiting (ejecta had odor of guaiacol) and profuse salivation were present. The pulse became rapid and weak and the breathing irregular. Cutaneous sensibility was diminished. Later on blood and bile-stained mucus were vomited. The urine was dark colored, of an aromatic odor, and contained

bile-pigments and a small amount of albumin. The cyanosis gradually diminished and was followed by a deadly pallor. The respirations became frequent. Jaundice appeared and the patient died on the third day. The autopsy revealed an acute gastro-enteritis and parenchymatous degeneration of the liver and heart muscle, acute hemorrhagic nephritis, enlarged spleen, and ecchymoses in the pleura, peritoneum, endocardium, and pericardium. Several cases of death have been reported following the hypodermic administration of guaiacol, the patients dying within an hour in profound coma with every symptom of cardiac paralysis.

Fifteen and a half minims (1 c.c.) of a mixture of guaiacol, 150 parts, and iodoform, 20 parts, injected into the knee-joint of a girl of 8 years suffering from fungous arthritis gave rise to cyanosis, dyspnea, loss of consciousness, nausea, and temporary amaurosis supervened. Von Mosetig-Moorhof (*Deut. med. Woch.*, No. 7, 1894).

Guaiacol is absorbed rapidly. Fifty to 60 minims ( $3\frac{1}{2}$  to 4 c.c.) are applied to the surface and the part is covered with oiled silk. Within fifteen minutes the pulse relaxes, the skin becomes cool and moist, and the temperature begins to fall. The effect lasts for four or five hours. The application may be repeated night and morning, according to the course of the fever. This means of employing this remedy should be used with care, as it is, when used in this way, that ill effects generally occur. On account of the rapid absorption of the drug, the fall of temperature may be rapid, descending below the normal, with cold extremities, clammy skin, feeble pulse, and other conditions of threatened collapse. Guaiacol is best applied mixed with equal parts of glycerin or oil. E. S. McKee (*Med. Bulletin*, Feb., 1907).

#### **Treatment of Guaiacol Poisoning.**

—Soluble sulphates (**Epsom** or **Glau-ber's salt**) may be given freely in conjunction with **mucilaginous drinks**. **Digitalis** and **strychnine** hypodermically injected are useful, associated with **heat** to the **extremities** and **counterirritation** applied on the **abdomen**. **Emetics** and the **stomach-pump** are valuable if used early, before the drug has been absorbed.

**THERAPEUTICS.**—Guaiacol has been chiefly used as a remedy in **tuberculosis**, and as an antipyretic in **fever**. It may be given in pill, in capsule, in an alcoholic or oily solution, or by hypodermic injection, dissolved in sweet almond oil (equal parts), or in sterilized neutral olive oil (1 to 5). Liquid guaiacol may be administered by inhalation, its volatility adapting it for that purpose. It may also be given by inunction; the part being cleansed and dried, the guaiacol is painted over the surface, and after being left for about ten minutes the part is well rubbed and covered with some impermeable dressing. Its absorption is very rapid, guaiacol being found in the urine fifteen or twenty minutes after it is applied to the skin.

**Pulmonary Disorders.**—In the early stage of tuberculosis guaiacol reduces the fever, restores the gastric and intestinal functions, and improves the condition of the patient. These effects have been ascribed to a bactericidal action on the specific bacillus and also to the formation of a compound with the toxins which annulled their pathogenicity, but the correctness of these views has not been shown. Its action, however, is probably similar to that of creosote (*q.v.*), which it contains in large proportion.

Bard and others found that the local application of guaiacol caused a marked reduction of the temperature. It may be painted over the thigh or the back, the part being covered with an impermeable towel. Dosage can thus easily be managed. The quantity at the beginning was  $\frac{3}{4}$  dram (3 c.c.), this amount being decreased at each treatment. Sajous has found this procedure very depressing in advanced tuberculosis. The antipyretic action of guaiacol was not confined to tuberculous cases, but has given satisfactory results in the acute pyrexia of **pneumonia**.

**Surgical Tuberculosis.**—The liquid may be used as a 1 in 10 to 1 in 20 solution in sterilized olive oil. Rigid antiseptic precautions are required for the injections, the latter being made with a Roux syringe deeply into the granulation masses,  $\frac{1}{2}$  to 1 c.c. (8 to 16 minims) of the solution being injected at three or four different points. This may be repeated once or twice every week, provided there has not been much irritation.

Guaiacol may also be used in the form of a dressing in certain open tuberculous conditions: thus gauze steeped in guaiacol solution (in olive oil, 1 in 10) and applied to the surface causes decrease of pain and induces a healthy condition of the tissues.

**Fever.**—Guaiacol possesses strong antipyretic powers. It is perhaps best used by painting over the skin of the abdomen, the chest, or the internal aspect of the thigh, 30 or 40 drops being used for this purpose, as described above. These applications may be repeated. The decline in temperature is often great and rapid, but after reaching the lowest point the temperature will more rapidly attain

its former height. A great feeling of depression is experienced by the patient and profuse sweating occurs when the temperature reaches the minimum, and chills at this time are not uncommon. The use of this drug for its antipyretic effect is not devoid of danger, and its action is not as lasting as that produced by the cold bath and by numerous other antipyretic remedies. Guaiacol carbonate has been used in typhoid fever, for its antiseptic action in the bowel, but such use is not to be advised.

J. M. Da Costa noted that on painting the skin with guaiacol in a case of **typhoid fever**, the temperature fell from 105.4° to 98.6° F. (40.7° to 37° C.) in three and a half hours without any disturbance of the circulatory or nervous system. Afterward the drug was used about twice daily, a fall of temperature occurring each time. The antipyretic effect is slower than that of the bath, but more permanent. After washing with soap and water, 30 drops should be slowly rubbed in the skin of the abdomen or thigh or painted over the surface, then covered with lint or wax-paper. Fifty drops should be the maximum amount. The urine should be watched carefully. The unpleasant odor caused by the drug may be to some extent overcome by the addition of oil of cloves.

This use of guaiacol is not recommended by Stolzenburg, Friedenwald and Hayden, and others. Although the fall of temperature is very marked, the sweating and rigors are very severe, and the influence on the disease is not lasting.

Great exhaustion is frequently produced. The effects may be obtained from 30 to 50 drops, and great care should therefore be exercised, the

drug being applied but once or twice daily, the initial dose not exceeding 30 drops. Its effect differs from the stimulating cold bath in being depressant. The main indication for its use is in diseases accompanied by high fever in which the cold bath cannot be applied, as well as in all other diseases accompanied by high fever in which irritability of the stomach prevents the use of other antipyretics.

Guaiacol has been used in the treatment of **malarial intermittent fevers** by Rogers and others; 15 minims (1 c.c.) were rubbed into the axilla and covered with cotton. The average fall of temperature in three-fourths hour was 1.6°, in one and three-fourths hours 2.3°, and after four hours the average fall was 3°. The fall of temperature was accompanied by a free perspiration and a marked improvement in the condition and comfort of the patient. No depression was noticed.

Guaiacol must be used with great care, both internally and externally. It has been used internally in **malaria** with success, in doses as high as 45 drops, after meals; and as much as 40 drops have been used over the abdomen three times a day with good success in malaria. When the stomach is irritated during malaria the external use of this remedy should not be lost sight of. In **toothache**, when the tooth is hollow, 1 drop on cotton put in the tooth will generally relieve it; but as small a quantity as 2 drops in a hollow tooth have produced poisonous effect. In **earache** it should be diluted with an equal part of olive oil, and 2 drops put in the ear. The external use of guaiacol gives satisfactory results in relieving most **pains**. In **continued fever** its external use over the abdomen will satisfactorily control the temperature, and it is used externally in **abscesses**, **epididymitis**, **orchitis**, **gout**, **neuralgia**,

**neuritis**, **pleurisy**, **pneumonia**, **rheumatism**, and applied on the tonsils with equal parts of olive oil in **tonsillitis**. J. A. Burnett (Wisc. Med. Recorder, vol. vi, No. 6, 1903).

The writer used guaiacol dissolved in olive oil (1 in 80) in the treatment of **variola**, having applied this oily solution at intervals of four hours to the affected skin. The results were decidedly beneficial, not only upon skin lesions, but also upon the fever. Out of 44 cases of confluent variola only 1 terminated fatally, which favorable result was ascribed by the author to the guaiacol treatment. J. Ridge (Brit. Med. Jour., p. 1257, vol. i, 1903).

The local application of a 10 per cent. ointment of guaiacol and salicylic acid is an excellent remedy for **exudative pleuritis** and **rheumatic joint affection**. Fluid which has persisted for weeks, despite internal remedies, is quickly absorbed and the pain of **rheumatism** is soon alleviated. Though pure guaiacol applied endermatically may give rise to symptoms of intoxication, these are never observed in a dilution of 10 per cent.. The only disadvantages is that the skin becomes like parchment after several applications and absorption is no longer so active; hence it is advisable to select a different portion of the body every time. D. Hecht (Münch. med. Woch., Feb. 28, 1905).

**Painful Disorders.**—The analgesic effects of guaiacol have been utilized in the treatment of **arthritis deformans**, **neuralgia**, **neuritis**, **acute articular and muscular rheumatism**, **sciatic coxalgia**, and **pains of a superficial or deep-seated nature**. The pains of **orchitis** and **epididymitis** are relieved by applying guaiacol in oily solution or in ointment (1 part to 10 or 15 of vaselin or lanolin).

Guaiacol has been recommended in cases of **gonorrheal orchitis** by Tavian. Crystalline guaiacol after previous melting may be applied to the

affected part and to the groin by a brush; 31 to 46 grains (2 to 3 Gm.) may be used each time. A guaiacol ointment may be made thus:—

R *Guaiacol* .....  $1\frac{1}{4}$  drams (5 c.c.).  
*Petrolatum* .....  $1\frac{3}{4}$  ounces (50 c.c.).

Leuz, in the cases of **epididymitis**, of **gonorrheal** origin, uses 10 per cent. ointment made with vaselin or a 5 per cent. used if the skin of the scrotum is tender. The scrotum is first washed with soap and with ether. This ointment is applied during the acute stage, and in from three to five days the fever, pain, and swelling disappear. In subacute stages the action of guaiacol is less active and very slight in chronic cases. After the acute stage it is best replaced by a 1 or 2 per cent. ointment of extract of belladonna, with equal parts of simple ointment and unguentum diachylon. Salol internally, 15 grains (1 Gm.) *ter die*, is a useful adjunct to the treatment.

The writer regrets that guaiacol is not used more for external application as its properties deserve, especially in local treatment of **neuralgia**, **neuritis**, **gout**, **chronic rheumatism**, and **traumatism**, in the form of a salve, and for application to the surface of the chest in lung, pleura, and febrile affections. He advocates a 10 per cent. solution or salve and observed excellent results from it in various cutaneous lesions, including **erysipelas**, **furuncles**, and **herpes zoster**. There are no untoward by-effects unless too large doses are used, over 1.5 to 3 Gm. ( $22\frac{1}{2}$  to 45 grains). Hecht (Therap. der Gegenwart, July, 1909).

**Anesthesia.**—As an anesthetic guaiacol may be used in minor surgical operations. A dose of 1 or 2 drops dissolved in sterilized olive oil is sufficient to obtain anesthesia; five minutes should be allowed to elapse

after the injection. Championnière considers guaiacol superior to cocaine, because much larger doses may be used with safety. No accidents were noticed except slight sloughing of the gums where it had been used for the extraction of teeth, which he attributed to a faulty method of injection or to a defective solution. Applied to **burns** in solution, 10 per cent., in olive oil, it causes a disappearance of the pain. Anesthesia is less rapidly produced than with cocaine, being complete only after seven or eight minutes; on the other hand, however, it appears to be much more durable. Anesthesia is induced even in inflamed tissue.

**Erysipelas.**—Guaiacol dissolved in alcohol or oil has been employed, as an application in this disease. Twenty to 30 drops may be painted over the infected area and slightly beyond. The pain is promptly relieved and the temperature lowered by this method of medication.

Excellent results were obtained by the writers from tamponing **purulent wounds** with gauze moistened with 20 to 30 drops of pure guaiacol. It even arrested the morbid process in one case of **fulminating gangrene** requiring amputation of the arm. After the operation the extension of the process in the muscles of the shoulder was completely checked by the guaiacol dressing. Prophorov and Bialobjesky (Semaine méd., vol. xxiv, No. 40, 1904).

The writer has been using for some time a mixture containing 1 dram 4 c.c.) each of guaiacol and ichthyol to the ounce of glycerin as a local antiseptic in the treatment of **infected wounds**. His results have been excellent. Gilbert (New Mex. Med. Jour., Aug., 1911).

C. SUMNER WITHERSTINE,  
 Philadelphia.

**GUARANA.**—Guarana is a dried paste, consisting chiefly of the crushed or pounded seeds of *Paullinia cupana* (*Paullinia sorbilis*), a climbing plant in the eastern part of South America, and especially in Brazil. It contains an alkaloid, guaranine, which is identical with caffeine and theine. Guarana is slightly soluble in water as well as in alcohol.

**PREPARATIONS AND DOSES.**—

The following were formerly official:—

*Guarana*, U. S. P. IX (guarana); dose,  $\frac{1}{4}$  to 2 drams (1 to 8 Gm.).

*Fluidextractum guaranae*, U. S. P. IX (fluidextract of guarana); dose,  $\frac{1}{4}$  to 2 drams (1 to 8 c.c.).

**PHYSIOLOGICAL ACTION.**—Guarana has a slightly bitter and astringent taste. It contains sufficient tannin to give it a slight astringent action. Farther than this, its action is that of caffeine.

**THERAPEUTICS.**—It is most frequently given for sick headaches or migraine. It is especially recommended when the pain affects the right side of the head. It shortens the attacks and in-

creases the interval between them. From 30 to 60 grains (2 to 4 Gm.) of the powder, or an equivalent of the fluidextract, may be taken every night and every three hours during the attack. It is also given as a tonic when nerve-action is impaired, as in convalescence from acute disease, debility, etc. W.

**GUINEA-WORM DISEASE.**

See PARASITES, DISEASES DUE TO.

**GUNSHOT WOUNDS OF ABDOMEN.** See ABDOMINAL INJURIES.

**GUNSHOT WOUNDS OF BRAIN.** See HEAD AND BRAIN, DISEASES OF.

**GUNSHOT WOUNDS OF HEAD.** See HEAD AND BRAIN, DISEASES OF.

**GUNSHOT WOUNDS OF STOMACH.** See ABDOMINAL INJURIES.

**GYPSUM.** See CALCIUM.

## H

**HAIR, DISEASES OF THE.**—

The main disorders of the hair, ALOPECIA and ALOPECIA AREATA, will be found treated in full in the first volume. SEBORRHEA is also treated under that head.

**ATROPHY OF THE HAIR.**

**Physiological Atrophy.**—Each hair has a certain span of life upon the completion of which it undergoes a physiological atrophy; it becomes separated from its papilla, which atrophies, a new papilla and a new hair being formed from the old follicle. Klein tells us that the lower part of the follicle, including the hair-bulb, degenerates also, and is gradually absorbed. There is then left only the upper part of the follicles and the hair-root, the fibers of which become fringed at the distal end and lost among the cells of the outer root-sheath, constituting the *hair-knob of Henle*. Later a cylindrical outgrowth of epithelial cells projects downward from the outer root-sheath and becomes invaginated over a new papilla.

Cell proliferation and multiplication follow and a new hair-bulb and hair are formed, and the old hair is gradually pushed out of the follicle as the new one slowly makes its way to the surface.

**Pathological Atrophy.**—Occasionally the hair undergoes a premature or pathological atrophy in its structure. Change takes place in part or all of its length, the diameter either increasing or becoming less. In one form, known as *trichorrhexis nodosa*, small, bulbous swellings having a dark or shiny appearance are found on the shaft of the hair at a single point or at irregular intervals. The hair becomes fragile and is liable to break off between and at these nodosities, leaving a ragged, brush-like end. These nodes occasionally result from the collection of pigment in the swellings, in the hairs presenting alternately bright and dark color, causing great disfigurement by the bead-like effect in the mass of hair. This form of atrophy is generally



confined to the beard and mustache, but is occasionally found elsewhere. A similar condition known as **pie**dra is common in Colombia and has been called **tricomy-cose nodulaire** by Juhel-Rénoy, who states that the nodes are formed by masses of very refractive spores glued together by a greenish-yellow material constituted by compact colonies of rods. The diameter of the spores is about 0.01 mm., somewhat larger than those of trichophytosis. This parasite is wholly exterior to the hair.

Remarkable wholesale incidence of trichorrhexis nodosa among school-girls. In addition to the manifest brittleness of the hair, the latter presented even to the naked eye the characteristic nodosities. The microscope showed the presence of the longitudinal fission. No sort of parasite could be found. The writers'



*Trichorrhexis nodosa*

material appears to show, perhaps for the first time, that a predisposition is necessary for the development of this affection under ordinary circumstances. This was evident because the nutrition of the nails and teeth showed manifest defects. Hübner and Walter (Münch. med. Woch., Jan. 16, 1912).

**Fragility of the hair** is another variety of atrophy, characterized by a brittle and cleft state of a part or the whole of the hair substance, often within as well as without the hair-follicle. This form is generally found on the head and beard, where the hairs are irregularly thin or flattened, rough, uneven along the shaft, brittle at points, breaking off and splitting up, often into several fibrillae. When the follicle is the seat of the alteration, the hairs may be found curled up within it; this often causes considerable irritation in the integument, especially in the region of the beard and of the lower limbs. Atrophy may be slight or marked; in the latter case great deformity is produced through the marked changes induced.

**Moniliform hair** is a rare form of atrophy of the hair in which nodular or fusiform swellings and narrow atrophic portions alternate all along the entire hair-shaft. The nodes are darker, giving a ringed appearance to the hair, which is brittle and inclined to break in the internodular portions, leaving the ends frayed and brush-like. This brittleness may cause most of the hair to break off near the scalp and leave bald patches resembling somewhat those produced by tinea tonsurans. Treatment is unsatisfactory.

The writer reports a marked case of moniliform hairs occurring in a boy aged 5 years. The affection began soon after birth, and was accompanied by a well-defined hyperkeratosis of the follicles not only on the scalp, but on the shoulders and extensor surfaces of the extremities. There was a distinct history of heredity, the father, a paternal aunt, and a cousin suffering from the same disease. The author believes that the spindle-like enlargements upon the hairs result from mechanical causes rather than from any pathological process. Bering (Archiv f. Dermat. u. Syph., Bd. lxxv, H. 1, 1906).

**ETIOLOGY.**—Atrophy of the hair may result from either local (seborrhea, eczema, parasites) or constitutional diseases (phthisis, malaria, syphilis, excesses of various kinds).

**TREATMENT.**—Remove the exciting cause, if possible. Re-establish nutrition by the use of tonics, **codliver oil**, and small doses of **sodium arsenate**, or **arsenic trioxide**. Pluck out the diseased hairs, or if they are numerous remove the diseased ends and rub into them a 10 per cent. ointment of **oleate of mercury**, once or twice daily. The entire surface of the scalp may be shaved, if a large number of hairs are involved, but it is preferable to cut off the affected ends. A close haircut will in more cases yield better results than shaving. Other forms of **mercury** (nitrate or ammoniated) may be used in ointment (1 to 8 or 1 to 16) with benzoated lard, with or without lanolin as a base. In addition to these, proper hygiene

of the scalp and stimulating lotions should be used. In most cases bland ointments to the scalp are beneficial.

Proper care of the hair and scalp will lessen or avert the tendency to atrophy.

#### CANITIES.

**SYNONYMS.**—Atrophy of the hair-pigment; grayness; whiteness or blanching of the hair; trichonosis; poliosis discolor.

In the consideration of atrophy of the hair we meet a condition in which there is a local or universal, partial or complete, loss of color in the hair due to atrophy of the hair-pigment.

This condition may be either congenital, premature, or the result of increasing age. The congenital form is met with in albinos. Premature grayness generally develops slowly, but many cases are recorded where the hair has turned suddenly gray or white within a few hours, or overnight.

The writer reports the case of a woman aged 48 who, while nursing a sister ill with some neuropathic affection, became herself melancholic. Her hair became uniformly thin and snow-white. As her health returned, a new and luxurious crop of dark-brown hair appeared. Jovel (Zeit. f. Hypnotismus, Bd. vii, H. 3, 1898).

Case observed in an insane-asylum. Upon admission his hair was of dark color both on the scalp and face. Within the short period of five weeks, it changed first to a gray and then very rapidly to a distinct white. There was no history in his family of any insanity, immediate or remote. R. Jones (Lancet, March 1, 1912).

**ETIOLOGY.**—Canities may be caused by any of the internal derangements which give rise to alopecia. A gradual or sudden atrophy of the hair-pigment may be brought about by cares, worry, anxiety, prolonged mental strain, shocks, and all conditions that profoundly impress the nervous system.

Certain foods and drugs, change in habits, seasons, and climate, and increase in age will cause atrophy of the hair-pigment. Arsenic or pilocarpine given internally has produced this effect. Exposure

to air and sun, exposure to chemical action, are active causes.

The writer believes that there is a large group of cases in which gray hair is acquired in association with nerve lesions, and therefore probably is connected with these changes. He reports 2 cases to illustrate his contention. His endeavor is to show that in such cases there is an epithelial change which takes place *pari passu* with the change in the nervous system, and which is probably due to it. Cheatle (Brit. Med. Jour., Aug. 31, 1912).

**PROGNOSIS.**—Premature canities is usually permanent. Rare cases have been reported where the pigment has returned to the hair, but these have generally been caused by some acute disease.

**TREATMENT.**—By the use of appropriate systemic treatment the change of color in the hair may sometimes be arrested in young persons, or may be concealed by the employment of agents that will, to a moderate degree, color the hair-substance. Useful remedies in this line are the oils of walnuts, of eggs, of mace, and of cassia. J. V. Shoemaker suggests a walnut hair-dye, prepared by bruising 40 parts of fresh green walnut peel with 5 parts of alum, and digesting with 200 parts of olive oil until all moisture has been driven off, straining and perfuming. Sage tea is useful, the hair being frequently sponged and washed with it. Tannic or gallic acid in oil, glycerin, or lard (1 to 8) often darkens the color of the hair. Gray or white hairs, if not too numerous, may be treated with any of the foregoing preparations, or they may be plucked out. If the grayness has become extensive, it can be concealed only by dyeing the hair.

The usual methods of dyeing the hair are given here to familiarize the reader with the subject, in order to enable him to meet untoward effects the use of hair dyes sometimes entails.

The proper use of hair-dyes implies a knowledge of the agent employed, the skill to increase or decrease its strength according to the shade required, and, finally, dextrous manipulation. Before using any dye the hair should be cleansed

with soap and water or with a solution of soda or of ammonia, and allowed to become thoroughly dry (usually takes an hour). The mineral dyes are the most active. The vegetable dyes are feeble in action and uncertain in effect, especially when used by an unskilled person, but, on the other hand, are generally less harmful, except, perhaps, pyrogalllic acid, the use of which may give rise to alarming symptoms. The most valuable vegetable dye is the Eastern or Persian combination of powdered dry **henna** and powdered **indigo plant**. These are mixed separately with water to form a thick paste. The henna paste is first spread on the hair. In the course of an hour a red color is obtained. The indigo paste is then applied in like manner. After the lapse of several hours, the hair is well washed with water and it is found to be dyed a deep black. Another method is to moisten the hair with a solution of **ammonium anacardate** (a doughy substance soluble in water), and then comb it with a comb dipped in **ferrous sulphate** (Gawalowsky). **Iron oleate** may be used instead of the sulphate, and the anacardate may be used in the form of an ointment or mixed with oil. **Chrysarobin**, **goa**, or **araroba powder** in ointment (1 or 2 in 8) with lard imparts a dark blue color to the hair. **Pyrogalllic acid** stains the hair a dark brown, and may be used in ointment or in solution with cologne and rose water. A brown color is also produced by the **salts of iron**.

**Nitrate of silver** in ointment or solution (1 to 4 in 32) is the best mineral dye. Shoemaker used the following method of application, using a solution by preference: With a good-sized comb in the left hand, the operator lifts up the locks of hair, and, with a soft, long-bristled toothbrush in the right hand, the dye is brought carefully in contact with the hair. The brush is moved up and down, rubbing the dye well in toward the hair-follicles, for, by reason of the arrangement of the hair-cells, the silver oxide, as it decomposes from the menstruum, is thus best communicated to the hair-substance. The dye should be kept from contact with the skin, and the hair should be quickly dried by rapidly fanning it. Any stain on the skin is removed by a solution

(1 in 32) of potassium iodide, of sodium sulphide (2 in 32), or even salt and water. The whole process requires from two to three hours, and must be repeated every four to eight weeks. The best blonde bleach is **dioxide of hydrogen**, but, light shades may also be obtained through the use of **turmeric** or **rhubarb**.

Concurrence of diabetes mellitus and premature canities in many members of 3 generations of a large family emphasized. Dermatologists agree that there is a marked hereditary element in premature canities, a disturbance in pigment metabolism, and that the hair cortex contains gas bubbles. According to Cady and Trotter, these bubbles probably consist of carbon dioxide. Bloch believes the propigment of the hair to be dioxy-phenylalanin ("*dopa*") related to tyrosin and adrenalin. A rational explanation of canities is afforded by Bloch's view that an enzyme, "*dopa oxydase*," in the cells of the epidermis and hair matrix, produces the pigment melanin by initiating or accelerating oxidation of the propigment. H. W. Traub (N. Y. Med. Jour., Aug. 15, 1923).

## HYPERTROPHY OF THE HAIR.

**SYNONYMS.**—Hirsuties; hypertrichosis; polytrichia; trichauxis.

Hypertrophy of the hair may consist either of an abnormal growth or an excessive growth of the hair, as regards either region, degree, age, or sex. Hypertrichosis may be congenital or acquired, and partial or general in distribution.

**Partial congenital hypertrichosis** is not uncommon and is most often present in the form of the hairy mole (*nevus pilosus*) or the warty mother's marks (*nevus verrucosus*). Hypertrichosis over the spine may conceal a spina bifida occulta (Sutton). Hairs in their growth sometimes take an abnormal direction within or without the follicle, especially upon the scalp, eyebrows, and eyelashes; when in the last they turn inward toward the eyeball they produce the affection called *trichiasis*. When hair develops between the eyebrows, or the arms, and on the face of women, forming a mustache or

beard, disfigurement and mental annoyance follow.

Besides the hairy moles cases have been reported in which an isolated, long wisp of hair has been present on the shoulder, scalp, or other part of the body.

[A birth is recalled in which the child had a tuft of dark hair, 2 inches long, situated on a circular base  $\frac{1}{2}$  inch in diameter, resembling the switch of a Chinaman. WITHERSTINE.]

**General congenital hypertrichosis** is a very rare condition; when it occurs there is usually a family history of hairiness. The case of Shwe-Maon, the hairy Burmese and his daughter, Maphoon, is a remarkable instance. The daughter married and had a daughter also hairy. Other cases are recorded, as the renowned dancer Negreni, whose hair increased over three yards in length after recovering from an acute disease; the case of Julia Pastrana, who had a fine beard and a hairy body; Adrian Jechtichow and his son Fedor (the dog-faced men); Barbara Urster, reported by Stricker, who had a beard reaching her waist. Certain races are noted for hairiness, such as the inhabitants of Jesso and Kurile, islands to the north of Japan.

**Acquired hypertrichosis** is a milder condition than the congenital and is seldom markedly general in distribution. Wilson reports an unmarried woman aged 33 in whom general hairiness started at puberty and continued until the whole body was covered excepting a bald spot on the top of her head.

During pregnancy a transitory hypertrichosis has been observed, which has disappeared spontaneously after parturition. Jackson reports an instance of this kind in a woman, who after giving birth to several children, suffered from amenorrhea, during which time coarse hair appeared on the face; she became pregnant several years later, and after labor the hairs disappeared.

**Partial acquired hypertrichosis** in varying degree is seen in some families in adult and in later life. Simple down, or lanugo, develops markedly or a number of coarse, scattered hairs or tufts may be seen on the chin, lips, or other place, resulting in whiskered boys and bearded

women. The case of a boy of 8 years with pubic hairs and a bearded face is reported by Chown. Lesser calls attention to a girl of 6 who started to grow pubic hair at 4, and began to menstruate at 3 years of age.

**ETIOLOGY.**—Heredity is apparently a causative factor, more marked in dark-complexioned families than in fair. Where hairiness has occurred in women it has been thought that the daughter has inherited the physical characteristics of the paternal line; this appears to have some reasonable basis, as excessive hair growth is frequently met in mannish women. The nervous system has an influence on this condition, insane women being more often the subjects of increased hairiness. Functional and organic diseases of the genitourinary tract, such as amenorrhea, sterility, hypernephroma (see ADRENALS, DISEASES OF THE), have been noted as causes. Dwarfs, monsters, and subjects of spina bifida and congenital deformities are apt to be subjects of this affection. Finally, the use of external irritants (blisters, sinapisms, stimulating lotions, heat) has been followed by increased capillary growth. The popular idea that the growth of hair is promoted by the use of animal fats, glycerin, and petrolatum does not appear to be well founded, though it is efficient in horses.

There is a popular idea among ladies that hair growth is promoted by the frequent employment of an animal fat in a face cream; glycerin and vaselin are also credited with this power of promoting hair growth. These substances by themselves are incapable of promoting hair growth, but the friction employed when using them is productive of hyperemia to the parts, so that possibly, in this way only, the hair roots may be stimulated. On the other hand, in treatment for loss of hair we often find that massage with grease and lotions fails to produce a growth of hair, or even to prevent its loss. Hair growth, therefore, may be promoted by the use of these substances only in these people who have a tendency to excessive hair growth, the resulting hyperemia being the ex-

citing cause. D. Freshwater (Pract., May, 1913).

**PROGNOSIS.**—Except when due to pregnancy or ill health, the hairy growth is, as a rule, permanent. The facial hair on women generally tends to increase in length, coarseness, and color, more especially at the menopause. As irritated moles may become malignant in nature, the hair on moles should not be removed by plucking or any other treatment likely to give rise to irritation; but removal of the hairs by electrolysis apparently causes the mole to atrophy, leaving but slight pigmentation.

**TREATMENT.**—The aim should be to destroy existing hair, and to inhibit further growth, or, at least, to lessen the deformity as much as possible. Success is to be looked for only when the growth is slight in extent. It is impossible to arrest the growth, but we may remove or destroy it, if slight. Eight methods of removal may be named, each of which has its special use: **Epilation**; **shaving**, **cutting**, and **singeing**; **depilatories**; **hydrogen dioxide**; **pumice-stone**; **Kromeyer's method**; **electrolysis**, and **X-rays**.

**Epilation.**—In olden times this was done by applying a pitch plaster and then forcibly tearing it off, bringing the hairs with it. Unna uses a resin pencil, the end slightly warmed, to extract isolated hairs. The use of the tweezers is both ancient and modern. This remedy is inefficient, or at least not permanent, as a new hair soon takes the place of the one extracted, and, if repeated too frequently, may induce inflammation of the hair-follicles.

**Shaving, Cutting, and Singeing.**—These also give temporary relief, but their repeated use is unattended with danger. In action they resemble that of the depilatories in that they remove that part of the hair above the level of the skin, and that they must be repeated at intervals. Their use is to be recommended where there is much hair on the face, arms, or legs; although this method may increase the coarseness of the hair, it cannot make new hair grow. Cutting the hair with scissors is tedious. Singeing may be done with the flame of the spirit lamp or a lighted taper.

**Depilatories.**—These have been employed since ancient times for the re-

moval of hairs. A depilatory is usually some form of sulphide (sodium, arsenic, barium, calcium), which by its chemical action softens and destroys that portion protruding above the skin, as lengthy application would destroy the skin as well. It is usually necessary to repeat the application every three or four days. The particular depilatory used is made in the form of a paste with water, applied with a piece of wood or bone to the affected area, and allowed to remain about ten minutes, when it becomes dry and is quickly removed. The parts are then cleansed with water, dried, anointed with cold cream or sweet oil, and later dusted with carbonate of zinc or magnesium. As the depilatory not only destroys the hair on a level with the skin, but also partially within the follicles, and as no black points or hair-stumps remain, this method is superior to shaving:—

*Redwood's formula:—*

℞ *Sol. barii sulphuri concentrati*,  
*Amyli*, āā q. s. ad ut ft. pasta.  
M.

*Duhring's formula:—*

℞ *Barii sulphidi* ..... ʒiij (12 Gm.).  
*Pulv. zinci oxidi*,  
*Amyli* ..... āā ʒj (30 Gm.).  
M.

The sulphide should be fresh or its action will be unsatisfactory.

**Hydrogen Dioxide.**—This remedy first bleaches the hair and makes it less apparent, and through continued use the growth of the hair is retarded. In using this it is best to dilute it one-half at first and gradually increase the strength. Bulkley advises the use of this preparation in cases when the hairs are too fine to admit of their removal by electrolysis, especially when they are numerous. The hairs after a time become brittle and break off. This is of special value to brunettes having fine dark down on the upper lip. It may also be used in cream:

℞ *Perhydrol* (Merck) ... ʒiiss (10 Gm.).  
*Adipis lana anhydrosi*.. ʒvj (24 Gm.).

This cream is less rapid in action, does not keep long, but its use is less troublesome.

In all cases where hydrogen dioxide is

used, the skin must be cleansed with ether and alcohol to remove the grease from the hair, which is necessary to permit of the action of the dioxide.

**Pumice-stone.**—This is a palliative remedy advised by Schwenter-Trachsler. A piece of pumice-stone, without rough edges, is rubbed gently over the affected part against the direction of the hair growth for a few minutes twice a day. The skin should not suffer damage by too hard rubbing, and should receive an inunction of cold cream after each rubbing is over. This is continued for six months. Rest a month and resume for another six months.

The writer has devised a knife in the shape of a small, narrow, rotating cylinder, driven by a pedal or motor. He has found it extremely useful for removal of superfluous hairs. It fits into the skin like a sharp punch, and cuts out a long, round plug. Each superfluous hair is punched out separately, leaving a minute, round, deep cavity. The hole is so small that it heals without leaving a perceptible trace. The region is first shaved; then the hairs are stained with henna, which colors the hairs only. The cylindrical knife is inserted slanting, parallel to the course of the hair. The pain is very slight, scarcely more than that of the prick of a needle, but ethyl chloride may be used when wished. Epilation by this means is a simple, rapid process; from 100 to 200 or even 300 hairs can be thus punched out at a single sitting. There is never any recurrence of the hairs if the punched-out plug includes the entire follicle. The cylindrical knives are from 0.7 to 1.2 mm. in diameter. They cut through the cutis into the loose, subcutaneous tissue, so that the plug comes out with the knife or is easily pulled out with pincers. Kromayer (Deut. med. Woch., Bd. xxxi, Nu. 5, 1905).

**Electrolysis.**—This method is best suited for the removal of coarse, single, or sparsely distributed hairs; where the growth is extensive or the hairs fine and downy this method is inapplicable. As each hair is destroyed singly, the opera-

tion is tedious and tiresome to both operator and patient. Not more than from 10 to 30 hairs can be treated at one sitting. The apparatus needed for the operation is an ordinary galvanic (not faradic) battery of from 6 to 15 cells, electric light street current with rheostat, or 6 large Leclanché cells, 2 electrodes, a sponge being on the positive (3 x 4 inches), and on the negative a fine platinum wire or a fine Cambric needle (No. 12) inserted in a small holder, a dead-beat milliampèremeter, a magnifying lens (or a pair of spectacles of + 1 to 3 D.), and a good broad-blade forceps.

The needle is carefully inserted into the hair-follicle down to the papilla. The patient, holding a moistened sponge electrode (positive pole) by the handle, completes the circuit by bringing the moistened sponge in contact with the palm of the other hand. After five to ten seconds a frothing will be seen at the mouth of the follicle. The current is then broken by the patient removing the sponge from the palm of the hand (releasing the positive pole), and the needle is withdrawn. Upon the slightest traction with the forceps the hair will usually come out; if it does not, the operation must be repeated. At the termination of the sitting, the patient's face should be bathed in hot water and anointed with cold cream; during the day apply some antiseptic evaporating lotion (calamine lotion or one of *aluminum acetate*). The wheal-like elevation remaining at the site of operation disappears in a few hours. The following points must be heeded to prevent scarring: The use of a fine needle; avoid too prolonged cauterization and too strong a current; operate on hairs at some distance from one another at the same sitting. A current  $\frac{1}{2}$  to 1 milliampère is sufficiently strong; 3 milliampères is the allowable maximum.

The electrolytic treatment advocated. The needle should be extremely fine and pointed. The electrode, which is the positive pole, may be about 3 in. square, and is covered with wet absorbent cotton. The needle-holder is invariably attached to the negative pole. The needle follows the hair follicle to a depth varying

from  $\frac{1}{16}$  to  $\frac{1}{8}$  in. If the needle is properly inserted a white foam or froth exudes. While it is still in place, the hair is removed with the slightest traction. A few minutes after, a tiny brown halo appears, showing that destruction has occurred. The scab generally falls within a week, leaving a brownish-red pigmented spot. This fades completely in 3 to 6 weeks, leaving in some cases a barely noticeable white scar, whereas in other cases no visible trace is left. L. K. McCafferty (N. Y. Med. Jour., Dec. 5, 1923).

Electrolysis, although the method of choice, is impracticable in pronounced hypertrichosis on account of visibility of the numerous small scars. Unna's resin pencil or the following mixture is harmless: **Tincture of iodine**, 3 parts; **turpentine**, 6; **castor oil**, 8, and **collodion**, to make 80. This is painted twice in thick layers over the area. The resulting thick film is then seized at its margin and pulled off, bringing away all the hairs embedded in it. G. Nohl (Med. Klin., Mar. 23, 1924).

The writer employs **diathermy**, *i.e.*, electrocoagulation, with the bipolar current of a modern high frequency machine. The needle is connected with 1 pole and another metal needle is attached to the skin. The needle is then inserted in the hair follicle and the current turned on with a foot-switch, with the machine set to give the smallest possible spark. About 80 ma. usually suffice. After 10 to 20 seconds the hair comes out without the slightest pull. From 75 to 100 hairs can be removed at 1 sitting. The percentage of recurrences is negligible, pain is considerably less than in electrolysis, and no subsequent scarring occurs. A. Rostenberg (Med. Jour. and Rec., June 17, 1925).

**X-rays.**—Favorable results have been obtained by the use of this form of treatment, but it is not without danger of producing a dermatitis involving serious and permanent changes in the skin (atrophic parchment-like condition, marked pigmentation, and the formation of telangiectases). Schamberg advises the use of the

X-rays on facial hypertrichosis only in severe and disfiguring cases in which the extent of the growth makes electrolysis a hopeless task. Walsh uses a combination of X-ray exposure and electrolysis.

Electrolysis is too tedious, painful and uncertain. The X-rays as advocated by Schiff and Freud, of Vienna, have been abandoned as too dangerous on account of the many and varied wave lengths. A method has been devised by Geyser that is at once safe, sure and permanent, by which only the **shortest wave lengths of X-rays** are selected by means of a magnetic wave selector. As a rule, the area is exposed once every 2 weeks and 3 to 5 exposures cause the hair shafts to become loosened. After 3 more exposures the papilla is, as a rule, completely absorbed. From such a papilla a hair can never again grow. Over 10,000 cases have been treated by this method. Where former X-ray treatment had resulted in wrinkling and drying of the skin, a practically normal appearance was eventually regained. W. Miller (Med. Jour. and Rec., June 4, 1924).

**DISORDERS OF SECRETION.** See SEBORRHEA SICCA (DANDRUFF).

### SYCOSIS NON-PARASITICA.

**SYNONYMS.**—Mentagra; folliculitis barbæ; lichen menti; coccogenic folliculitis; sycosis vulgaris.

Sycosis non-parasitica is a non-contagious, inflammatory disease, acute or chronic in its course, involving the hair-follicles, principally of the bearded part of the face or mustache, but occasionally the eyebrows or other parts. It is characterized by the development at once of pustules, papules, and perhaps tubercles, usually perforated with hairs, and accompanied by more or less infiltration. There is suppuration in the hair-follicles, with inflamed skin around them. The disease tends to last indefinitely and sometimes results in scars. Simple sycosis often attacks persons who have never been shaved at a barber's.

**TREATMENT.**—The employment of both constitutional and local treatment gives the best results.

Internal treatment is best begun with a purge, preferably one of the mercurials followed by a saline cathartic. The diet should consist of easily digestible and nutritious foods, cheese being strictly prohibited. In the debilitated or those out of health the simple bitters, alone or combined with a mineral acid and strychnine, are useful. In marked debility massage and static electricity are advised. The combined internal and external use of phytolacca has yielded good results. Iron, arsenic, phosphorus, and codliver oil are beneficial. The iodide of iron in dose of 2 to 3 grains (0.12 to 0.18 Gm.), given in pill three or four times daily, is particularly serviceable. If there is much inflammatory thickening of the parts, Tilbury Fox recommends the use of the liquor arsenici et hydrargyri iodidi, 3 to 10 drops thrice daily. If the tendency to pus formation be marked, the hypophosphites, calcium sulphide, or potassium chlorate will do good service.

**External or Local Treatment.**—The three stages of the disease, suppuration, dermatitis, and constitutional reaction, each demand special measures. In the first stage the hair may be cut short or allowed to remain in the natural condition, providing it will not mask the disease or interfere with the local applications; shaving, says Shoemaker, which is usually recommended, is painful. He has never seen it followed by good results. Remove all scabs and crusts by means of oil-dressings or a poultice. As local applications some prefer lotions, either warm or cold, such as lead-water and laudanum, weak solutions of witch-hazel, zinc, or lead acetate, or of bichloride. Others prefer oily applications, such as oil of ergot, olive oil with fluid oleate of mercury, or codliver oil, alone or combined with arrowroot, zinc, or lead carbonate, opium, or belladonna, which may be lightly painted over the surface. Among the serviceable ointments at this stage are the zinc, lead, and bismuth oleates, alone or combined with other agents; calomel or white precipitate, 10 grains (0.65 Gm.) to the ounce (30 Gm.) of cold cream, is a valuable preparation. So also is diachylon ointment with a few grains of camphor added.

In the later stage more stimulating ap-

plications are effective. The ointment of oleate of mercury (5 to 20 per cent., according to the condition of the parts) may be applied alone or with other remedies. The ointment of the nitrate of mercury, in from 1 to 3 drams (4 to 12 Gm.) to the ounce (30 Gm.) of zinc ointment, is useful. Sulphur, tar, betanaphthol, or other antiseptic may be combined with any of the preparations named.

Resorcin, ichthyol, corrosive sublimate, salicylic or boric acid may be used. Veill commends a 2 per cent. alcoholic solution of pyrogalllic acid, while Pick uses an alcoholic solution of tar. Provans's tragacanth paste is a soothing, antiseptic application:—

R *Tragacantha* ..... 3iv (16 Gm.).  
*Glycerini* ..... f3iv (16 Gm.).  
*Sodii boratis* ..... 3ss (2 Gm.).  
*Aqua destillata* ..... q. s.

M.

Epilation becomes unnecessary if the parts are thoroughly depleted by opening the various lesions with a knife, and puncturing the surface thoroughly, relieving the enlarged and congested blood-vessels, allowing the stagnated blood to circulate, the effused serum to escape, and inhibiting the formation of pus.

The abstraction of blood should be resorted to from one to three times a week, the parts bathed with warm water to encourage the bleeding, then mopped dry, and the medication carefully applied on the surface. The incisions and punctures heal rapidly, the induration becomes less, the symptoms disappear, and cure results without scar or deformity. Bockhart advises that the patient should use a face lotion of 1 per cent. sublimate solution freely twice a day for some time after active treatment has ended.

The constitutional treatment is both local and general. In the former use an astringent wash (sulphate of zinc) upon the skin area; in the general treatment use such as would be appropriate in eczematous conditions.

Local treatment of sycosis must take into account two processes: 1, a suppurative process; 2, a dermatitis remaining after suppuration has been overcome. The first phase



of the treatment consists of cutting the hairs close to the skin and applying antiseptic measures, such as 10 per cent. **resorcin solution**, sprayed on the parts three times daily, and wet dressings of **boric acid solution**, kept in contact with the skin throughout the day and night and renewed five times in the twenty-four hours. Where the hair-follicles show deep suppuration the resulting pustules should be opened, either with an appropriate pointed instrument or by pulling out the central hair. Where the pustules are very numerous, **depilation** of the entire area, either by means of the X-rays or with forceps, is indicated. Antiseptic measures should then be continued until the acute process has subsided; if necessary, depilation may be practised again, three weeks or a month later.

In the succeeding period of simple dermatitis, the following preparations are useful:—

- ℞ *Styrax ointment* ..... 1 part.  
*Oil of sweet almond* ... 2 parts. M.  
 Or,  
 ℞ *Calomel or turpeth mineral*.. 1 Gm. (15 grains).  
*Zinc oxide* .... 3 Gm. (45 grains).  
*Petrolatum* .... 30 Gm. (1 ounce).  
 M.

Where these ointments are insufficient, various agents used in eczema, such as tar, oil of cade, salicylic acid, etc., may be tried. Thus:—

- ℞ *Salicylic acid* . 0.5 Gm. (7½ grains).  
*Resorcinol* .... 1 Gm. (15 grains).  
*Oil of cade* ... 5 Gm. (1¼ drams).  
*Zinc oxide* ... 10 Gm. (2½ drams).  
*Petrolatum* ... 30 Gm. (1 ounce).

M. et ft. ung.

Sulphur preparations, too irritating in acute forms, may be used in the more sluggish cases:—

- ℞ *Precipitated sulphur* ..... 1 to 3 Gm. (15 to 45 grains).  
*Tannic acid* .. 1 Gm. (15 grains).  
*Zinc oxide* .. 2 Gm. (30 grains).  
*Petrolatum* ... 30 Gm. (1 ounce).

M. et ft. ung.

In altogether chronic cases, with thickening and induration of the skin, linear scarifications may be resorted to. Sabatié (*Progrès méd.*, Dec. 23, 1911).

### PARASITIC DISORDERS.—TINEA FAVOSA.

**SYNONYMS.**—Favus; porrigo favosa; dermatomycosis favosa; Erbgrind (G.); crusted ringworm; honeycomb ringworm.

*Tinea favosa* is a contagious vegetable parasitic disease produced by the *Achorion Schönleini*. It is characterized by the formation of small, round or oval, cup-shaped, pale-yellow, brittle crusts, which are usually situated over the hair-follicles, and are perforated by hairs. The name favus—a honeycomb—was suggested by their resemblance to a honeycomb.

**TREATMENT.**—Patients who are debilitated and those of syphilitic or scrofulous diathesis should receive internal treatment suited to them. **Codliver oil** and **syrup of the iodide of iron**, with good, **nourishing food**, **fresh air**, and **healthful exercise**, are indicated.

Thorough and persistent local treatment is necessary if we would destroy the parasite. The first indication is the **removal of the crusts**; the second, the use of an antiparasitic to destroy the fungus on the surface as well as in the hairs and hair-follicles. The best means for removing firm crusts is by saturating them, for twenty-four hours, with oils, of which the **oil of ergot** will be found the most effective. Olive, almond, and phenolized oils are not so suitable. Poultices are not only unpleasant, but injurious, as they increase the growth through their heat and moisture, and increase the swelling of the epidermis to such an extent that the use of the antiparasitics is interfered with. Warm dressings and bandages produce the same effects. The German soap-spirit acts destructively on the skin. An antiparasitic lotion which is detergent, antiseptic, and softens the crusts is a 25 or 50 per cent. solution of **boroglyceride**, sponged thoroughly over the affected area, after the crusts have been covered with **oil of ergot** for twenty-four hours. In one or two hours the crusts will easily peel off, and the skin will be clear and clean, ready for one of the potent anti-

parasitics. Shoemaker prefers the **naphtholized zinc oleate ointment**. The hair and skin are first well dried, and after a few hours the antiparasitic is freely applied over the affected surface, the best being the **oleates of mercury** and of **copper**, the definite chemical compounds, not the solution of the oxides in oleic acid. He prescribes them as follows:—

℞ *Ung. hydrargyri oleatis*,  
*Adipis* ..... āā ʒiv (16 Gm.).

℞ *Cupri oleatis* ..... ʒss (2 Gm.).  
*Adipis* ..... ʒj (30 Gm.).

M.

A little of the former ointment is first well rubbed in with the finger-tips, and after a few days alternated with the latter, which is astringent and relieves any irritation set up by the former. These applications should be made every day or two, and continued for three or four weeks. If after cessation of treatment for a week or two the hair does not assume its natural aspect, and new favus crusts develop, the treatment should be renewed. After the crusts have been removed, the use of water, for any reason, is prohibited. A single hair extracted from each of the diseased spots will show when treatment has been sufficient. Other efficient remedies are **resorcin ointment**, a 10 per cent. ointment of **boric acid**, **chrysarobin**, **thymol iodide**, and **europen**.

Schamberg advises that the diseased hairs be first **depilated** and then **parasiticide ointments** and lotions used. Sabouraud has successfully used the **Röntgen rays** in favus. The difficult technique is the main objection to its use.

### TINEA TRICHOPHYTINA.

**SYNONYMS.**—Ringworm; *tinea sycosis*; *sycosis parasitica*.

This is a contagious parasitic disease affecting the hair and the hair-follicles, as well as the nails and epidermis, being caused by a microscopic vegetable fungus known as the *trichophyton*. It is characterized by the formation of circular erythematous or grayish scaly patches, vesicles, and tubercles, upon which the hairs are ragged, broken, or destroyed. When the scalp is attacked the disease is known as *tinea tonsurans* or *tinea trichophytina capitis*; when the beard is affected

it is called *tinea sycosis* or *tinea trichophytina barbae*; when the nails are affected it is known as *onychomycosis* or *tinea trichophytina unguium*; when on the body it is known as *tinea circinata* or *tinea trichophytina corporis*.

**TREATMENT.**—Schamberg recommends daily **soap** and **hot water** cleansings of the scalp with **tar**, **phenol**, or **sublimate soaps**; **depilation** of diseased hairs and of those surrounding the affected areas, and, finally, the use of **parasiticide ointments** and lotions. The keynote of success is the thorough and persevering use of the preparation that gives a successful result. **Ointments of betanaphthol** or of **iodine** (1 in 8); of **chrysarobin** (1 or 2 in 24); of **sulphur** or of **tar** (1 or 2 in 8); of **phenol** (1 in 20). He especially recommends brushing into the patches several times a day the following:—

℞ *Olei cadini*,  
*Olei olivæ* ..... āā fʒj (30 Gm.).

M.

In the morning a **carbolic soap** is used with hot water. The following also yields good results:—

℞ *Sulphuris præcipitati*,  
*Betanaphtholi* ..... āā ʒj (4 Gm.).  
*Petrolati* ..... ʒj (30 Gm.).

M.

**Croton oil**, **chrysarobin**, and **pyrogallol acid** have been used with the idea of producing follicular suppuration and thus hastening the cure.

The **X-ray** treatment of *tinea tonsurans* has been developed to that point, by Sabouraud, that he often cures a patch in one treatment. The dosage is measured by the effects of the rays upon discs charged with barium platinocyanide, which changes in color. He insists that the dose be carefully measured. The treatments are given at a distance of 15 cm.; the discs are fixed midway between the patient and the source of the rays. From ten to fifteen minutes' exposure is usually sufficient. He prefers a large static machine and tubes of small diameter and of high vacuum. After from eighteen to thirty-five days the hairs fall. After the exposure the head is painted every day with a 10 per cent. **tincture of iodine**; daily **soap** and **water washings** are used

after the eighteenth day. Restoration of the hair begins after two months, the affected areas being bald in the mean time.

### PEDICULOSIS.

**SYNONYMS.**—Phthiriasis; lousiness; Läuseucht (G.); pou (F.).

This is a contagious disease caused by animal parasites called pediculi, or lice, which attack the skin and with the exception of the body-louse live and propagate in the hairy portions of the body. When domiciled in the head, it is known as *pediculus capitis*; when in the hair of the genitalia, it is called *pediculus pubis*; a third variety, infesting the clothing, along the seams, is known as *pediculus corporis* or *vestimenti* (body- or clothes- louse). The latter caused trouble during the great war.

On the head *pediculi capitis* are found mostly in the occipital region and when present eggs or nits are to be found, which appear as small, opaque, white, globular bodies, attached closely to the hair-shaft by a glue-like substance, usually near the hair-roots in recent cases, but in old cases near the extremities of the hairs. In neglected and chronic cases the head, with its dirty, matted, twisted, and glued-together hairs, filled with decomposed pus, crusts, lice, and nits, presents a condition known as "*plica polonica*."

The *pediculus pubis*, or crab louse, the smallest of the three lives in the pubic region, and at times the axillæ, eyebrows, eyelashes, beard, mons veneris, and the sternal region, thighs, abdomen, and scrotum, if supplied with hair.

**TREATMENT.**—The indications are to destroy the lice and their ova (nits), and to restore the skin to its normal condition. For the former purpose we may use **betanaphthol**, the **mercurials**, **tobacco**, **coccus indicus**, **staphisagria**, **sabadilla**, **phenol**, and **sulphur**, in powder, lotions, infusions, ointments, and in the form of soaps. **Crude petroleum**, or **kerosene** alone or mixed with **sweet oil**, is efficient. The nits may be destroyed by solutions of **soda** or of **borax**, **vinegar**, dilute **acetic acid** and **alcohol**.

In pediculosis capitis, as an alternative to the use of petroleum, Whitfield's method is simple and reliable: The hair is saturated with hot 1:40

**phenol** solution, the patient, if a girl, lying on her back with her head projecting over a basin on a chair. The hair is placed in the basin, into which the phenol solution is poured over the head from before backwards. The excess of fluid is squeezed out of the hair, which is then enveloped in a towel and left from 1 to 2 hours before being dried completely.

In pediculosis corporis the parasite may lay its eggs on the pubic hair and other parts of the trunk as well as on the clothing; sterilization of the latter is, therefore, not necessarily sufficient. A **hot bath**, followed by a few inunctions of an ointment of **ammoniated mercury** (2 per cent.), **stavesacre** (ung. staphisagriae, B. P.) or **sulphur** (2 to 3 per cent.), with thorough **disinfection of the clothes and bed-linen** (by boiling when practicable, the remainder being heated in an oven to 160-175° F.) is adequate. The secondarily infected lesions should be treated by **frequent bathing**, **evacuation of abscesses**, **removal of crusts**, and a weak **mercurial ointment**.

In pediculosis pubis the writer applies pads of lint, soaked in 1:40 **phenol** and covered with oiled silk and a bandage, to the affected regions for an hour or so. Later it is wise to use a weak **mercurial ointment** for a few days. H. W. Barber (Lancet, Feb. 3, 1923).

### NEUROTIC DISORDERS.—TRICHOPATHOPHOBIA.

Under this name are included all cases of mental worry about the hair, on account of its loss, its color or change of color, and its excessive or misplaced growth. The loss of hair is most often a cause of worry, to women; in men, rarely, except in those who are syphilitic. Worry on account of the color of hair is unusual except that certain shades of red may give rise to distress. Worry over the graying of the hair sometimes drives women to the use of hair-dyes, to their harm. Worry over superfluous hairy growths is the most serious form of trichopathophobia; insanity not infrequently develops from this, especially in neuropathic women.

Mewborn suggests that perverted or arrested activity of the sexual functions may be an etiological factor in this condition, and that there is good evidence of the influence of ovarian secretion on the growth of hair.

### VOLUNTARY ERECTION OF THE HAIR.

Violent emotion and the reflex action of cold are known to produce goose-flesh (*cutis anserina*), which is merely a bulging of the hair-follicles, and an erection of the hairs, through the contraction of the *arrectores pilorum* muscles, which are attached to the hair-follicles. Voluntary erection of the hair is rare, but Maxwell reported a case in a young man, in whom the condition was best seen on the hips, thighs, back, and arms. He also had an unusual control of the facial muscles, being able to move the skin of his scalp freely in various directions and to move his ears simultaneously or singly. His powers were not the result of practice, but were apparently inherited from his father, who possessed them to a considerable degree. Erection of the hairs was accompanied by sensations of pleasure, and afforded relief from headache. There were accompanying vasomotor changes, shown by a contraction in volume of the finger; also dilatation of the pupil. A biopsy was performed to determine whether the *arrectores pilorum* contained striated muscle or not. Only smooth muscle was found. W.

**HAMAMELIS.**—Hamamelis, or witchhazel, consists of the bark, twigs, and leaves of *Hamamelis virginiana*, a North American shrub growing east of the Mississippi River.

The leaves contain about 10 per cent. of tannin, bitter and odorous extractives, and a trace of oil.

**PREPARATIONS AND DOSES.**—*Hamamelidis cortex*, U. S. P. VIII (witchhazel bark and twigs); dose, 30 gr. (2 Gm.). *Hamamelidis folia*, N. F. (witchhazel leaves); dose, 30 grains (2 Gm.).

*Fluidextractum hamamelidis foliorum*, N. F. (fluidextract of hamamelis leaves); dose, 30 minims (2 c.c.).

*Aqua hamamelidis*, U. S. P. IX (witchhazel water); dose, 2 drams (8 c.c.). Pre-

pared by distilling the entire shrub with steam or water and adding 15 per cent. (vol.) of grain alcohol. Usually known as extract of witchhazel.

**THERAPEUTICS.**—Hamamelis is hemostatic, astringent, and tonic in its action. Containing considerable tannin, it coagulates the albuminous elements of the tissues when applied locally, and diminishes the blood-supply and secretions.

**In Hemorrhage.**—The fluidextract has been given internally for the relief of pulmonary, renal, and uterine hemorrhage; purpura, hematemeses, varicose veins and hemorrhoids.

The local application of hamamelis has likewise been used for recent wounds, sprains, bruises, superficial hemorrhage, hemorrhoids, epistaxis, and for bleedings or discharges from the natural cavities or openings of the body.

Hamamelis is exceedingly useful in capillary hemorrhage. In cases of intermenstrual oozing, where the endometrium is lax and congested, if fluidextract of hamamelis be swabbed over the entire inner surface the oozing will cease, and if repeated every few days it will become healthy.

Sore and bleeding gums, relaxed uvula, and oral ulcers will heal if the following is used every two or three hours:—

*R Aqua hamamelidis,*

*Aqua rose* .....ãã 3vj (180 c.c.).

It possesses marked sedative properties, and patients will often cease to complain of pain in a sprained joint or congested area after a compress of hamamelis has been applied. The distilled extract makes a very nice application for burns and herpetic eruptions. H. R. Caston (*Therap. Gaz.; Med. Bulletin*, Feb., 1907).

**As an Astringent.**—Hamamelis is used, in diluted form as a mouth-wash, as a gargle in chronic pharyngitis, and in spray after attacks of acute coryza (1 part to 8, or 1 part to 24).

In relaxed conditions of the mucous membranes generally hamamelis is beneficial. Peristalsis and the secretions of enteritis are checked. It is of value in diarrhea and dysentery. S.

**HAMMER TOE.** See ORTHOPEDIC SURGERY.

**HAND, CLUB.** See ORTHOPEDIC SURGERY.

**HANOT'S CIRRHOSIS.** See CIRRHOSIS OF THE LIVER.

**HARELIP.** See SURG. ANAPLASTY.

**HASHISH.** See CANNABIS INDICA.

**HAY FEVER.** See HYPERESTHETIC RHINITIS.

## **HEAD AND BRAIN, DISEASES OF.**

### **DISEASES OF THE SCALP.**

**CONTUSIONS.**—These are commonly the result of blows or falls, which leave the patient more or less stunned, and cause an effusion of blood into the tissues, which may amount to a hematoma. Localized swelling occurs at the point of impact, which is due to hemorrhage and effusion under the scalp, the latter being raised up into a soft, semi-fluctuating tumor, the edges of which are regular, pit on pressure (sometimes with moist crepitation), feel hard, and are usually above the contour of the head, while the center feels soft. In some cases this extravasation simulates a depressed fracture of the skull, especially in children, and this deceptive feeling will occur without any considerable extravasation of blood beneath the scalp, the depressed center being due to the compression of the scalp by the blow that has inflicted it (Erichsen). In case of doubt it will be safer to make an incision so as to examine the state of the bone, but usually the smooth bone can be felt at the bottom of the soft central depression.

**Treatment.**—The treatment of contusion of the scalp is very simple.

The use of some evaporating lotion, or **lead-water** and **laudanum**, with **slight pressure** is usually sufficient. Under no circumstances should the swelling be punctured or the blood let out in any other way. Erichsen has found contusion of the scalp in girls and young women in some cases to be followed by severe neuralgic pains in the part struck. In such cases **incisions** down to the bone have been followed by improvement. See also **WOUNDS OF SCALP.**

The treatment of the various forms of injury is well described by Lawrence as follows: Contusions of the scalp caused by slight blows or falls, and accompanied by a moderate amount of effusion, are simple and require little treatment. Contusions of the scalp caused by sharp blows or severe falls are always to be examined carefully, and a guarded prognosis given. Those accompanied by large effusions, and especially if pulsating, should be treated by **shaving the scalp, incising, and turning out clots** (examining carefully the pericranium and skull), securing bleeding points, closing with **sutures**, preferably braided silk, and dressing with **dry antiseptic dressing**, which should only be removed when absolutely necessary, before the fourth or fifth day, when the sutures should be removed, and a light compress **bandage** applied. Those accompanied by little or no swelling, when caused by severe blows, should be carefully watched, and, on the first appearance of local fever or swelling, should be **freely incised, washed out, and treated as open wounds**. If the case is not seen until the patient has had chills; hot, dry skin; hard pulse, fever-coated tongue, nausea or vomiting,

insomnia, nervous twitchings, or any other symptoms of meningeal inflammation, we should cut down and **trephine** at once over site of injury. While inflammation of either pericranium or the meninges is one of the things likely to follow these injuries, it may be prevented by early **incision**. Where caries of bone or meningitis occurs, the cause may generally be found to be injury of the pericranium, which becomes inflamed; effusion follows thereupon, then inflammation of the vessels from pressure, and then, by extension, meningitis.

#### WOUNDS OF THE SCALP.—

These are of common occurrence, and are more serious than similar injuries located elsewhere, especially in persons of vitiated or impaired constitution. These injuries are more likely to be followed by erysipelas, and have a great tendency to the propagation of inflammatory action inward to the brain, which latter gives a serious or even fatal aspect to comparatively slight lesions. It must not be forgotten, however, that the blow or fall which occasions the scalp wound may cause fracture of the skull, or produce concussion or even laceration of the brain.

Insofar as injuries of the tissues of the scalp are concerned, there is little danger, for they are freely supplied with blood and endowed with great vitality, so that repair is favored and sloughing seldom occurs even when the tissues are severely contused and extensively lacerated, the existence of a slight pedicle of attachment sufficing to insure the vitality of a large flap. It is, therefore, important to save all portions of the lacerated tissue unless entirely detached.

**Treatment.**—In all wounds except very small ones the head should be carefully examined for fracture of the skull or, in the absence of this, for signs of concussion or intracranial hemorrhage. The **scalp** should be **shaved** over a wide area, to insure thorough cleansing and disinfection. All dirt and foreign matters should be removed by **rubbing the surface with olive oil, washing well with Castile soap** and warm water, and finally scrubbing the surface thoroughly with a solution of **bichloride of mercury** (1:1000). If the wound be a simple cut, it will often suffice to bring the edges together with a strip or two of **adhesive plaster**; it is generally better to bring the edges together and secure them accurately with **sutures**. A generous **sublimate dressing** should be applied and retained by a recurrent **head bandage**.

Though the scalp be bruised, lacerated, and begrimed with dirt, as well as wounded, or a larger or smaller flap be separated from the bone, none should be cut away; but after shaving the head and arresting hemorrhage by ligature or compression, it should be cleansed and disinfected thoroughly and the parts replaced in their proper positions. Usually drainage will be required until granulations have formed.

In scalp avulsion **Ollier-Thiersch skin flaps** should be applied early, waiting only a few days after the injury. The writer cuts large flaps, 3 or 4 cm. wide and 10 to 15 cm. long, and covers the entire surface, the flaps adjoining or even overlapping. They are always autogenous. Lenormant (Jour. de chir., xvii, 9, 1921).

Of 26 cases of scalp avulsion the outcome was not known in 2, but 20 patients recovered. The defect was filled with **Thiersch flaps**. Attempts

to apply flaps taken from the scalp proved only partially successful, as only a few of the flaps—prepared according to the Wolfe-Krause technique—healed in place. The rest of the defect was covered with Thiersch flaps from the thighs, five different sittings being required for this Thiersch flap transplantation. Enz (*Correspondenzbl. f. schweizer Aerzte*, Bd. xxxv, Nu. 21-22, 1907).

Case of a young woman from the top of whose head a portion of the scalp  $6\frac{3}{4}$  by  $7\frac{3}{4}$  inches, was torn. It was placed in **normal salt solution** after thorough cleansing, the hair shaved, the edges trimmed, the scalp sewed on, using a continuous suture, and a gauze dressing applied. On the third day, the center seemed dead and was dissected off, and the wound dressed with a solution of **chlorinated soda**, 1 dram (4 c.c.) to the pint (500 c.c.). At the end of one week only a strip of tissue,  $\frac{1}{2}$  inch wide, extending halfway round the scalp, was left. The cranial bones were kept covered with petrolatum and the scalp dressed with compresses of normal salt solution. Granulations appeared, and by the fifth week covered the greater part of the vault; **skin grafting** was then commenced (Thiersch's method) and continued every day for eight weeks. Lawrence (*Jour. A. M. A.*, June 17, 1911).

In extensive scalp wounds in which a portion of the cranial surface is entirely exposed, there is no tendency to granulation over the bone, and grafts will not take hold. In order to excite granulation over the cranium, one need but drill a few small holes in the external table to set free the connective tissue of the diploe. From 10 to 50 such holes may be made about 1 centimeter apart. Under a normal saline solution compress renewed every 2 or 3 days, reddish islets of granulation tissue appear through the holes and extend over the bony surface. In a few weeks the bone is covered, and **epidermal grafts** can be successfully applied. J. Labouré (*Presse méd.*, June 14, 1917).

**TRAUMATIC OR SPURIOUS MENINGOCELE.**—This is a collection of cerebrospinal fluid beneath the scalp following a fracture. It is usually found in children. The tumor pulsates, transmits an impulse on coughing, and may be reducible. The treatment consists of **excision** of the **sac** and **closure** of the **opening** in the membranes.

**ABSCESS OF THE SCALP.**—Abscess of the scalp may follow erysipelalous inflammation, contusions, infection from the exterior, disease of the cranial bones, or the imperfect disinfection and careless dressing of wounds of the scalp.

The symptoms of abscess are an erysipelalous condition of the scalp, accompanied with pain and usually marked edema and pitting on pressure. There is usually some fever, at times intense and often accompanied with delirium. There is great danger from the burrowing of the pus; if it burrow beneath the pericranium, and sometimes if more superficial, there is danger that the inflammation may extend inward to the brain through the vascular openings in the skull and cause meningitis.

**Treatment.**—Free incision should be made, as soon as the abscess is discovered, at the most dependent point. **Disinfection** of the wound and **drainage** should be followed by **antiseptic dressings** and **drainage**.

**CAPUT SUCCEDANEUM.**—During the birth of a child extravasation of blood and serum not infrequently occurs in that part of the scalp which presents, as a result of the passive congestion. The extravasation varies in degree according to the duration of labor and the severity of the pains. This swelling is called **caput suc-**

cedaneum. The seat of this extravasation is in the loose connective tissue external to the pericranium. The tumor is usually situated over the occipital or parietal bones near the posterior fontanelle, and is soft and painless.

This condition seldom requires treatment, as it gradually diminishes in size and finally disappears in a few days or weeks.

**TUMORS.**—A common form is the *sebaceous tumor*, or *wen*. Varying in size from that of a pin's head to an orange, occurring singly or multiple, of slow growth, smooth, round or oval in shape, movable beneath the integument, they are familiar objects. They are readily diagnosed from fatty tumors by their firmer consistence and smoother surface; evacuation and examination of contents will remove any doubt. The sebaceous cyst is distinguished from abscess by its slow growth, history, situation, mobility, and elasticity; the existence of the dilated opening of the sebaceous duct and the expression and examination of some of its contents will confirm the diagnosis.

**Treatment.**—**Extirpation** is indicated. After cleansing the hair and scalp the hair is evenly parted over the tumor, an incision made down to the sac, and the tumor enucleated. To prevent return, the sac should be entirely removed. Hutchinson reports a case in which an aggregation of small sebaceous tumors of the scalp became malignant in character. He, however, remarked the rarity of such disposition in sebaceous tumors.

**Horns.**—If let alone, it occasionally happens that the sebaceous matter exudes through the sebaceous duct, and forms a scab or crust,

which by a process of subdeposition becomes conical; and being gradually pushed up from below, and assuming a dark-brown color by exposure, it forms an excrescence that resembles a horn. **Surgical removal** is indicated.

**Warts and Moles.**—Warts and moles are cutaneous hypertrophies. Warts when non-irritating and small require no attention, but, if they show a tendency to grow, they should be removed by the knife, as they sometimes display a malignant character. Moles are of two kinds: the hairy and the pigmented. Treatment is by **surgical removal** under **cocaine anesthesia**. A subsequent **plastic operation** or **transplantation of skin** may be necessary to cover over the denuded surface.

**Fatty Tumors.**—Fatty tumors are rarely met with in the scalp. They resemble somewhat the sebaceous cyst, but are flatter, less globular, and more deeply seated. The treatment is similar to that of the sebaceous cyst: **extirpation**.

**Congenital Cysts, Fibromata.**—Congenital cysts (sebaceous and dermoid), fibromata, are occasionally found in the scalp. They are easily recognized and removed.

**VASCULAR GROWTHS.**—See also BLOOD-VESSELS, TUMORS OF. **Capillary Varix, Nevus, Erectile Tumor, Vascular Growth, or Mother's Mark.**—Of these, two varieties are noted, depending upon the size of the capillary vessels which make up the tumor. When the capillary vessels are large, they usually form a *raspberry-like tumor*, at first small in size and somewhat elevated above the skin. Their tendency, if let alone, is to increase steadily in size, the capil-



lary walls becoming thinner, until danger from serious hemorrhage threatens. This variety should be removed early, especially if the tumor shows any tendency to grow in size or to extend laterally. If small, the tumors may be removed by **excision** or **ligature**, the base in the latter procedure being transfixed by a harelip-pin and the ligature passed beneath it before tying. If larger, two pins may be inserted at right angles to each other, or a double ligature may be passed around a single pin; the larger tumors are best ligated in sections. In any case care must be taken to insure the removal of the entire tumor.

The *port-wine mark* is composed of small capillary vessels; extends over more or less surface, and exhibits little or no tendency to spread. It is more unsightly than dangerous. It is best removed by **excision**, if not too large, making the incisions so that a linear scar only shall remain. A small portion of the mark may be frozen, the surface cross-hatched with a fine knife, and the hemorrhage arrested by firm pressure with sterilized blotting-paper. This process, repeated until the whole surface of the tumor has been treated, is practically painless and leaves no appreciable scar. The cautery and escharotics have been used with success, but are not to be advised, on account of the unsightly scars which are left.

#### **DISEASES OF THE SKULL.—**

FOR FRACTURES OF THE BONES OF THE SKULL, see FRACTURES. FOR NON-PENETRATING WOUNDS OF THE SKULL, see CEREBRAL CONCUSSION AND WOUNDS OF THE BRAIN, this article.

#### **PENETRATING WOUNDS OF THE SKULL AND BRAIN.—**These

are produced by severe blows or falls; by kicks; by the penetration of knives, swords, bayonets, rifle balls, etc.; by sharp spicula of depressed fractures, and by *contrecoup* with or without fracture. These wounds may be received on sides or vault of the cranium or through the mouth, nose, or orbit. These wounds are usually accompanied by fracture of the skull: in many cases punctured fractures of most dangerous character. They are all more or less septic in character, with laceration of the brain substance, the deposition of foreign bodies (fragments of bone, hair, clothing, bullets, etc.), more or less severe hemorrhage, and in many cases with loss of brain substance. More rarely—as in children—the wound may be received through the fontanelle, or in adults through a large parietal opening without accompanying fracture.

**Symptoms and Diagnosis.**—The symptoms and results of the wound vary according to the age of the patient, seat and extent of the injury, septic conditions of the weapon and wound, etc. In some cases the symptoms are very slight and much delayed, but more often are severe and promptly manifested, and are proportionate to the extent of the injury.

If the injury be moderate, headache occurs, with all the symptoms of encephalitis in course, followed by coma and death if not soon relieved. The most valuable symptoms tending toward such relief are the localizing symptoms, which may often reveal a hidden injury. If the injury involves the structures at the base of the brain governing the respiratory act, immediate death must ensue. If the anterior lobes and upper parts of the

hemispheres be injured, but slight symptoms may occur. Twitching of the muscles and epileptiform fits are symptoms of cerebral laceration, and these complicating stertor or alternating with it make the diagnosis clear.

In those cases in which no external wound exists we may suspect laceration if we find that the ordinary signs of compression or concussion are associated with symptoms that do not ordinarily present themselves in these conditions when uncomplicated, such as contraction of one pupil, dilatation of the other, or an alternation of these states with convulsive twitchings of the limbs, hemiplegia of one side, or paralysis of one arm and the opposite leg, with perhaps involuntary spasmodic movements of the other members. In laceration of the brain without compression the pupils are contracted. When laceration and compression are both present, one pupil may be dilated and the other contracted; or both will be dilated or contracted according to the predominance of the symptoms of compression or of laceration. These irregular symptoms, accompanied by much coldness of the surfaces, slow pulse, and depression of vital power, indicate cerebral laceration. Paralysis due to a cerebral lesion is always manifested on the opposite side of the body, but not necessarily opposite to that on which the blow was received, as the injury may be from *contrecoup*.

Glycosuria is an occasional consequence of injury to the brain, and the location is usually referred to the central part of the medulla oblongata and the floor of the fourth ventricle. Blindness may result from in-

jury to the optic nerves at any part; ptosis and strabismus result from injury to the third, fourth, or sixth nerve. The seventh nerve most frequently suffers, being not uncommonly torn across in fractures of the petrous portion of the temporal bone, either in its facial or auditory portion, producing either facial paralysis or deafness. Injury to the eighth nerve is rare, and patients rarely survive who give evidence of the lesion. Motor aphasia points to a wound above and in front of left ear; word-blindness, or apraxia, points to an injury above and behind the ear; hemianopsia indicates a wound of the cuneus; paralysis of face, arm, or leg would point to their respective cortical centers as the seat of injury.

**Prognosis.**—The danger of wounds of the brain is greatest and most immediate in injuries of the base, of the pons, and of the crura cerebri; it is least and most remote when the seat of the lesion is in the upper and anterior part of the hemispheres, in some cases there being no positive indication of any injury when so located. Unless the pons or medulla have been wounded, the patient seldom dies at once. Children often bear extensive injuries to the brain, and even considerable loss of brain substance, without immediate or remote effects of serious nature. As a general rule, the younger the patient, the greater the chance of recovery. The prognosis is usually more favorable in men of the laboring classes.

**Treatment.**—In these injuries to the brain the head should be clean shaved, and the parts thoroughly washed, scrubbed, and cleansed with an antiseptic solution. All foreign bodies on the outside should be

washed away or removed with forceps. Modern preference is for excision of the wound in the soft parts, bone and dura. Foreign bodies, fragments of bone, etc., which have entered the brain should be removed. Disinfection of the brain cavity and arrest of hemorrhage by pressure, hot water, or ligature should follow. The dura may be sutured, missing portions being covered in by a portion of the pericranium. The wound should be drained, preferably by rubber tissue, as a rubber tube is apt to become occluded. Hull has advised the use of a silver wire, bent like a hair-pin and wrapped with rubber tissue and a gauze bandage, the whole being fastened together with a  $\frac{1}{8}$  inch Carrel tube by ligatures. The wire is bent so as to carry the device deeply into the wound and the outer portion fastened to the scalp with adhesive. Hypertonic (5 per cent.) sodium chloride solution is injected through the Carrel tube at intervals.

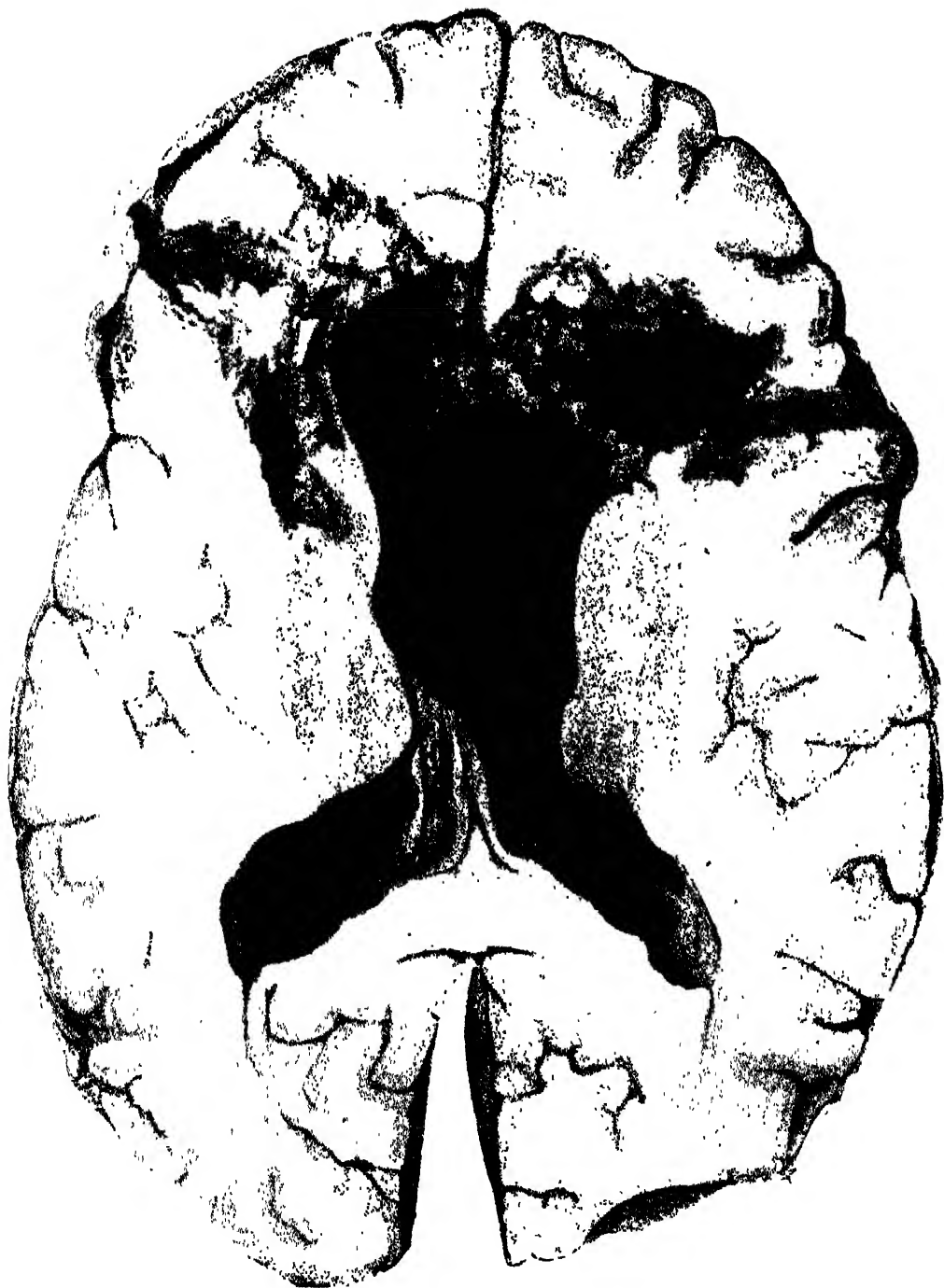
The flaps of scalp are to be sutured in so far as is feasible, and an antiseptic dressing applied. Methenamine may be given by the mouth. If secondary abscess develops—and it should be carefully watched for,—the pus should be evacuated as soon as detected.

Of 67 brain injuries, 11 were treated by wound excision, a plastic flap operation, and primary suture. Of these, 8 were living 3 years later. In 22 cases of primary closure, however, it was necessary to reopen the wound later in 8 cases because of abscess formation. Whenever primary suture was done it was followed by increased brain pressure. Albrecht recommends instead tampon treatment and lumbar puncture. If such puncture is ineffective on account of adhesions or clots, puncture of the corpus callosum

or suboccipital drainage is used. Prolapse was never observed in treatment by lumbar puncture, 39 cases being treated with good results. The first tampon was left in for 12 days and lumbar puncture used to prevent prolapse. The indications for puncture are brain pressure, collapse and a tendency to prolapse when the tampons are changed, threatened perforation of the ventricles, and symptoms of meningitis. Good results from puncture were obtained even in progressive encephalitis. F. Demmer (Beitr. z. klin. Chir., cxxi, 491, 1921).

In simple or compound depressed fracture with localized brain contusion, with or without indriven bone fragments, débridement is indicated. Contused brain and blood-clot are carefully removed by catheter suction. The dural opening is accurately closed if possible, and the bone defect is partially filled by replacing the fragments of bone that have been removed. In simple scalp lacerations, the wound edges should be trimmed away and the wound carefully closed with fine silk sutures. Unless this is done, especially if there is a slight injury to the underlying structures, brain abscess may follow. J. C. Weaver (Surg., Gyn. and Obst., Sept., 1925).

**GUNSHOT WOUNDS OF THE HEAD.**—These injuries may involve the integrity of the scalp, the skull, or the brain. The serious nature of these lesions is not always appreciable at first sight. A glancing shot may have injured apparently the scalp alone, while in reality the skull may have suffered such injury that necrosis of the bone will follow, fracture of the internal table, perhaps with splintering or depression; or even the brain and its membranes may be at once or later involved. In these injuries the scalp often sloughs extensively, the tissues being devitalized by the "energy" of the ball; perforation or deep penetration is not



Gunshot wound of the brain.



the only means by which the energy of a projectile is measured, for its disruptive, tissue-destroying powers are of equal importance. In other, more serious cases extensive injuries of the brain and skull may result. Tillmanns has shown by experiments on animals that a bullet in its passage through the brain does not leave a smooth track, but that it leaves, behind it, tears which radiate out from it. The gray substance is usually more torn than the white; this suggests that the latter is firmer.

When gunshot wounds involve the brain they may be either perforating or penetrating; perforating, when the missile passes entirely through the head, and penetrating when the missile enters the brain, but does not emerge. The severity of the injury to brain or skull varies within very wide limits. The wound of exit is always larger than that of entrance; this difference is more marked in the skull than in the soft parts. In a perforating wound of the skull the wound of entrance in the external table may be very small, while the inner table may be severely fractured; at the wound of exit the outer table usually suffers most, and the entire opening will be much larger than the wound of entrance. Besides the presence of the missile, there may be fragments of hair, bone, etc., and hemorrhage and infection, as explained in WOUNDS OF THE BRAIN.

The symptoms are similar to those given under WOUNDS OF THE BRAIN and FRACTURES. Localizing symptoms, however, may be absent more or less completely, owing to the far-reaching effects of such injuries.

The bullet track in gunshot wounds of the brain is often of considerable

size, like a cavity, with a diameter much greater than that of the opening through the dura. When such a cavity is not over 7 centimeters deep and large enough to admit a finger the writers prefer finger palpation to Cushing's method of catheter palpation for the removal of the foreign body.

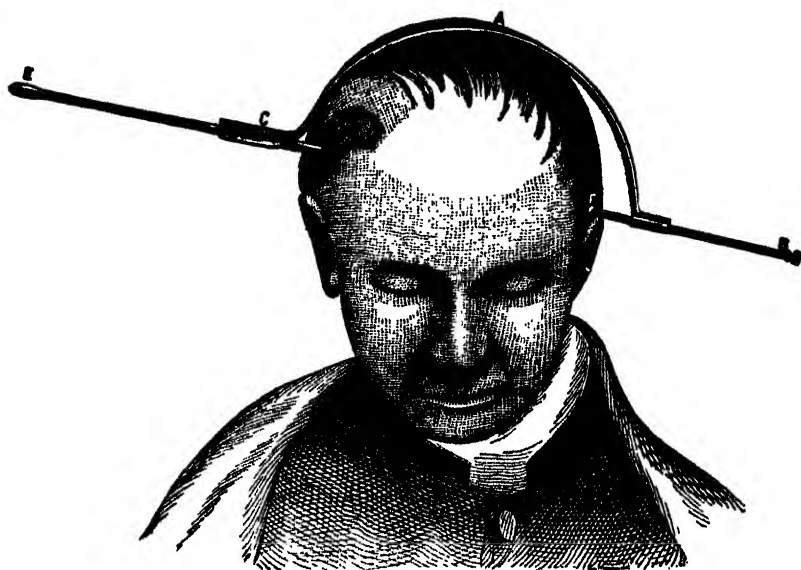
Cleaning out the cavity with forceps under careful finger control gives absolute insurance against sepsis, and only very rarely causes increased cerebral trauma. Brain wounds not suitable for finger palpation must be cleaned as well as possible by the catheter method, curettage, or magnet extraction, or a combination of these methods. Towne and Goethals (Ann. of Surg., May, 1920).

**Treatment.**—In many cases rigid protection of the wound against infection may render further interference unnecessary. Balls and bullets often become encysted. Yet this course involves a risk of sepsis. If operation is decided on, the entire scalp should be shaved and disinfected (see TECHNIQUE OF INTRACRANIAL SURGERY in this article). If any serious hemorrhage be present, the wound of entrance or the wound of exit or both may be freely enlarged with the rongeur forceps or the trephine, and the vessels secured by ligature, by pressure, or with hemostatic forceps. A safer procedure as regards later infection, however, is to excise the wound and turn down a large flap for the further manipulations. The bullet or missile must be removed if possible, a counteropening being made, if necessary, for this purpose. Secure free drainage; if need be, by a counteropening; the drainage-tube may, for this purpose, have to traverse the entire brain. Antiseptic dressings should be applied, and treatment con-

tinued upon the general principles of cerebral surgery.

Devices have been introduced to facilitate the finding of the bullet, etc. Girdner's "telephone probe" is an ingenious instrument in which one end of the probe is attached to a telephone receiver which may be fastened to the ear. If the probe touches the ball, it will indicate it by a grat-

(E). The probe is allowed to gravitate along the track of the bullet until it is arrested; the groove of the trajectory is then applied to the probe, and the movable rod on the other end is moved in until it comes in contact with the skull (F). This will represent the point where the bullet impinged upon the skull opposite the point of entrance, in case it has



Morgan's trajectory.  
(Indiana Medical Journal.)

ing sound. If the ball is not over  $2\frac{1}{4}$  inches from the surface, Girdner's "induction balance" may also indicate its location, and the counteropening may be made close to the ball.

Morgan, of Indianapolis, has devised what he calls a "trajector" for determining the course of a bullet in gunshot wounds of the skull. It is composed of a solid steel bow (A) in the end of which is a movable rod (BF). The opposite end of the bow is supplied with a triangular groove (C) on its under surface, so that it will adjust itself to the searching probe

passed through the brain, and therefore the point for countertrephining.

Fluhrer's aluminum probe consists of an aluminum shaft, 12 inches long, tipped with large conical ends of various sizes. It is so light that when allowed to enter the tract of the ball vertically, it will do so by its own weight and will not make a false passage.

Finally, the value of the Röntgen rays, or X-rays, need hardly be emphasized. A series of skiagraphs may be taken, different portions of the skull being exposed in succession.

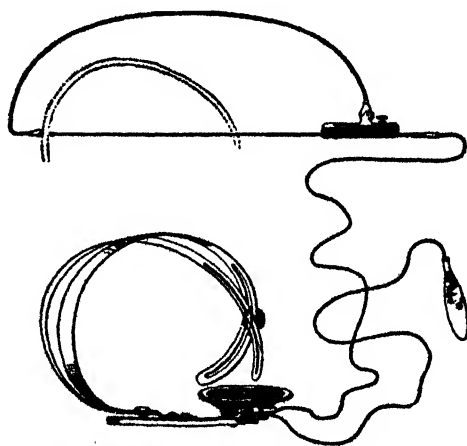
Reid's base line marked by a piece of lead wire will show in the skiagraphs.

F. G. Winter, of Brooklyn, has devised an instrument which combines the principles of Morgan's trajector, Fowler's pressure probe, and Girdner's telephone probe. The trajector consists of a solid bow of aluminum with bulbous tip on the distal end; the proximal pole is hinged to a small steel plate, which is rabbeted to fit a groove on the sliding handle of the pressure-gauge probe. The portion of stem of probe projecting beyond handle is for attachment of the telephonic apparatus. Instead of hand-receiver, a head-receiver may be used, leaving both hands free. (Girdner's telephonic apparatus consists of receiver, conducting wires, bullet probe, and mouthpiece.)

**FUNGUS, OR HERNIA, CEREBRI.**—When a laceration of the brain and dura mater communicates with a fracture of the skull, it is usually found, especially in children, that a dark-brown or bloody fungus-like mass of cerebral matter protrudes from the wound. This protrusion takes place at any time—a few days to several weeks—after the receipt of the injury. It has been noticed by Guthrie, and confirmed by others, that hernia cerebri is more likely to take place through small than large apertures in the cranial bones. After its appearance the tumor increases quite rapidly to the size of a hen's egg, or even larger, and pulsates synchronously with the brain. In composition and structure it varies. Sometimes it is composed chiefly, if not entirely, of extravasated blood; but the true fungus cerebri consists generally of connective-tissue growth (neuroglia), rarely containing much

true brain substance, but may consist of softened and disintegrated cerebral matter infiltrated with lymph and blood. Under the base of the tumor the softening and red discoloration of the brain extend for some little distance. There may be more or less discharge from the fungus, and escape of cerebrospinal fluid from the interior of the ventricles. It is apt to bleed.

In this affection the mental condition of the patient may not be much



Winter's apparatus for locating bullets.

disturbed at first, although there is generally evidence of cerebral irritation. In many cases stupor speedily comes on, however, and death eventually occurs from encephalitis followed by coma consequent upon the development and increase of intracranial inflammatory effusion. In other cases cicatrization of the surface, with retraction of the tumor, takes place and recovery follows.

As a prophylactic measure the suggestion made by Keen may be carried out: that whenever removal of the dura or brain substance is rendered necessary during the course of operation, a piece of the pericranium



should be entirely detached from the under surface of the scalp flap, turned upside down so that the osteogenetic surface shall be uppermost, and secured to the dura by a few interrupted sutures.

**Treatment.**—The treatment of this condition is not entirely satisfactory. If the tumor is cut off by the knife or destroyed by the cautery, it generally sprouts out anew, though in rare instances removal has not been followed by reproduction. The best results generally follow the use of **antiseptic dressings** changed once or twice daily, healing taking place by granulation. If it heals slowly, **skin-grafting** may be resorted to. As soon as cicatrization has been completed there is a sudden subsidence, so that, in the place of a bulging mass, there is a marked depression, which is permanent, and may amount to as much as  $1\frac{1}{2}$  inches. Pressure by dressings or sponges, though sometimes useful, must be abandoned if followed by symptoms of intracranial pressure or by convulsions.

**PNEUMATOCELE.**—Pneumatocele, or a tumor filled with air, may result from spontaneous atrophy of the osseous tissues, producing a communication with the mastoid cells. The air then extends underneath the pericranium, forming a painless, smooth, elastic tumor, which is tympanitic to percussion, and which disappears, usually, under pressure. The treatment ordinarily employed is to empty the sac by **pressure** or **aspiration** and then apply a compress and roller bandage.

**MICROCEPHALUS.**—When a child is born with complete ossification of the skull, even at the fontanelles, or when ossification is com-

pleted soon after birth, microcephalus generally results. To remedy this condition and allow a more rapid expansion and growth of the brain Lannelongue has suggested that a groove, about  $\frac{1}{4}$  inch wide, be excised in the skull. This may be made on one side of the sagittal suture or on both sides, and may extend from the front line of the hair on the middle of the forehead well back into the occipital bone, and may have lateral branches. This operation should be done on only one side at a time, and is not devoid of danger, since the general vitality of such children is usually impaired. Keen, of Philadelphia, reduces the time of operation to not more than thirty minutes by using a rongeur forceps which he has devised for the purpose. Stewart, of Philadelphia, denounces this operation as useless.

**INFLAMMATION, PERIOSTITIS, OSTEITIS, CARIES, and NECROSIS** may occur in the cranial bones. The symptoms are very similar to those produced by the same processes elsewhere. In necrosis of the cranial bones there is always the danger of extension of the inflammation to the membranes of the brain and inflammatory effusion within the skull, producing convulsions, coma, or death. Affection of the petrous portion of the temporal bone gives rise to the greatest danger, on account of the homogeneous structure of the bone and the continuity of the dura mater with the lining of the cavities by which it is perforated. When the frontal bone or the vault is the seat of disease, cerebral complications are less likely to occur.

**Symptoms.**—When the vault or forehead is affected there is tender-

ness, with some puffiness, and gradual elevation of the scalp into an abscess. If this be opened, the necrosed bone may be seen or felt at the bottom of a sinus or unhealed ulcer. When the petrous portion of the temporal bone is affected, there will be a history of earache, followed by a profuse fetid discharge from the ear, with tympanic perforation, escape of the middle-ear bones, and deafness. When the sphenoid or ethmoid is affected, deep-seated pains in the head, persistent edema of the eyelids, and a fetid discharge from the nose will be present.

**Etiology.**—These inflammatory disorders of the cranial bones are usually consequent upon injury or constitutional syphilis; more rarely they result from struma (tuberculosis) or follow typhoid fever.

**Prognosis.**—Necrosis of the petrous portion of the temporal bone is generally incurable, death usually resulting from encephalitis. In necrosis of the sphenoid or ethmoid little can be expected from operative interference, though in the latter case portions of the sequestrum may occasionally be extracted through the nasal cavity.

**Treatment.**—The treatment of the inflammatory disorders of the bones of the skull follows the general rule of treatment of these disorders. It is, however, especially important that by absolute cleanliness, frequent dressings, and the liberal use of antiseptics the parts be kept, as far as possible, in an aseptic condition. (See also article on BONES, DISEASES OF.)

**HYPERTROPHY OF THE BONES OF THE SKULL**, with increase of density and obliteration of the diploë, may result from osteitis

deformans or hereditary syphilis. Treatment is seldom required.

[A very interesting specimen of hyperostosis cranii given by Herwirsch to the College of Physicians of Philadelphia was from a woman aged 71, who enjoyed good health up to her 64th year, when rheumatism confined her to bed for one year. During this illness enlargement of head began. She became listless, disinclined to any conversation, and made frequent cries at night. She had insomnia, and near her death she refused food and be-



Hyperostosis of the cranium. (Herwirsch.)

came comatose. Skull at thickest part (right occipital) measured 3.5 cm.; at the frontal, 2 cm., and at the thinnest portion (left temporal), 1.4 cm.; weight of skull-cap 1870 Gm. (4 pounds, 2 ounces).]

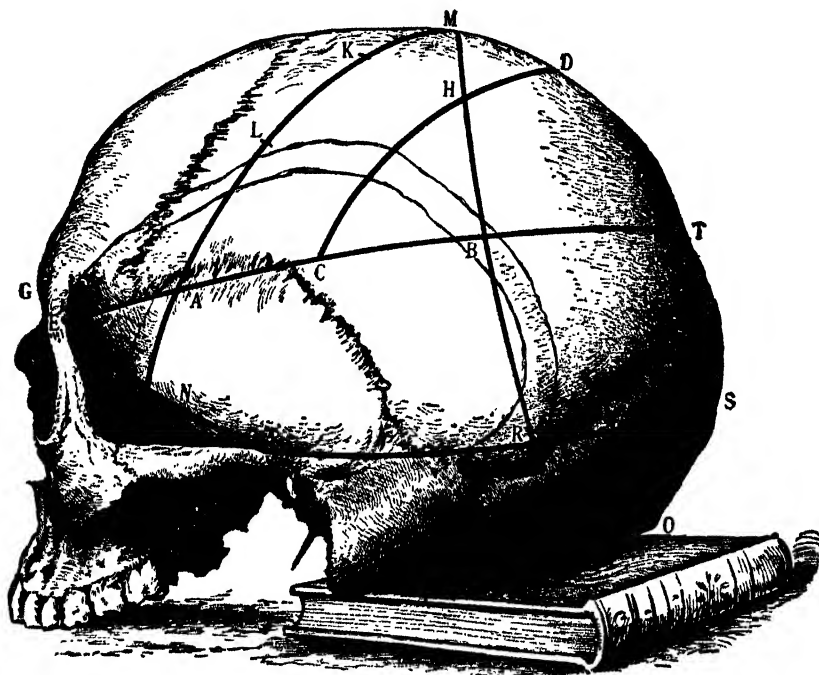
**ATROPHY OF THE BONES OF THE SKULL.**—This condition is often observed in senile skulls, and appears to be one of the phases of general wasting atrophy incident to senility. When observed in young subjects this condition is generally due to hereditary syphilis. The cranial bones may become so thin that they will crackle on slight pressure. Its favorite location is the

occipital bones; it is often called *craniotabes*. The **treatment** for these latter cases is that for **hereditary syphilis** combined with **codliver oil** and the **hypophosphites of lime and soda**. All mechanical injuries—blows, falls, etc.—must be averted.

**TUMORS OF THE SKULL.**—Exostosis, or bony tumor, may occur

side corresponds with a similar growth within the skull.

Round-, spindle-, and giant-celled *sarcoma* may affect the bones of the skull. The tumor may arise in the dura, the diploë, or in the periosteum. As the size of the tumor increases so does the danger and deformity. *Sarcoma* arising from the dura perforates



Cerebral localization. (*Chiene*.)  
(*Edinburgh Medical Journal*.)

as a result of injury, but is usually a tertiary syphilitic manifestation, a result of a syphilitic gumma. If the growth is within the skull it is called an *enostosis*; if external, *exostosis*.

The general treatment is that for syphilis of the bones. If the tumor is external and gives annoyance, it may be **removed**. If internal, and it can be located by its pressure effects upon the brain, the **skull** should be **trepined** and the **tumor removed**. Sometimes a growth upon the out-

the cranium and sometimes spreads underneath the scalp, finally breaking through the latter. The opening in the bone, the pulsation of the mass, its partial or complete reducibility, generally accompanied with symptoms of pressure, and the presence of the optic neuritis which often results from it enable one to diagnose this growth.

The growth may be removed, but recurrence always follows. The operation itself involves such danger as

often to be fatal, especially if the superior longitudinal sinus be involved.

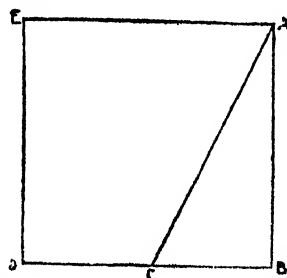
*Epithelioma* sometimes invades the cranial bones. Like sarcoma, it is a malignant disease, and is treated on the same general principles.

## SURGERY OF THE BRAIN.

### CEREBRAL LOCALIZATION.—

In addition to the motor areas around the fissure of Rolando, operating surgeons should be familiar with the relations of the temporosphenoidal lobe with ear disease; the supramarginal convolutions in puncture of the lateral ventricles; the angular convolution in word-blindness; the occipital lobe in lesions of sight; in fact, the relations of the whole brain, except the anterior extremities of the parietal lobes. Chiene, of Edinburgh, suggests the following method of cerebral localization: Shave the head and find, in the median line of the skull, between the glabella (*G*) and the external occipital protuberance (*O*), the following points: The midpoint (*M*), the three-fourths point (*T*), and the seven-eighths point (*S*). Find also the external angular process (*E*) and the root of the zygoma (*P*) immediately above and in front of the external auditory meatus. Having found these five points, join *EP*, *PS*, and *ET*. Bisect *EP* and *PS* at *N* and *R*; also bisect *AB* at *C* and draw *CD* parallel to *AM*. The pentagon (*ACBRPN*) corresponds to the temporosphenoidal lobe, with the exception of its apex, which is a little in front of *N*. *MDCA* corresponds to the Rolandic area, containing the fissure of Rolando, and the ascending frontal and the ascending parietal convolutions. *A* is over the anterior branch of the middle meningeal artery and the bifur-

cation of the Sylvian fissure; *AC* follows its horizontal limb. The lateral sinus at its highest point touches the line *PS* at *R*. *MA* corresponds to the precentral sulcus, and, if it be trisected at *K* and *L*, these points will correspond to the origins of the superior and inferior frontal sulci. The supramarginal convolution lies in the triangle *HBC*. The angular gyrus is at *B*. The fissure of Rolando extends from  $\frac{1}{2}$  inch behind the midpoint between the glabella and the inion, downward and forward, for  $3\frac{3}{8}$  inches at an angle of  $67\frac{1}{2}$  degrees. This angle may be



Method of finding the fissure of Rolando.  
(Stewart.)

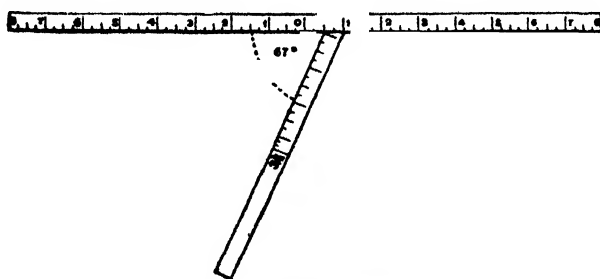
found by taking a square piece of paper and folding one corner back on the line *AC*, i.e., from the middle of the line *DB* to the corner *A*. The side *EA* is then placed on the middle line of the head, and the line *AC* corresponds to the fissure of Rolando, the angle *EAC* being  $67\frac{1}{2}$  degrees. Horsley's cyrtometer is an instrument for marking out the fissure of Rolando. (For motor, speech, and special sensory areas, etc., see illustrations in TUMORS OF THE BRAIN.)

**TECHNIQUE OF INTRACRANIAL SURGERY.**—It is important to notice that these operations may be rendered necessary by traumatic or pathological lesions. The two

should be considered quite separately, since comparison between them is almost impossible. In traumatic cases operation is undertaken, as a matter of necessity, suddenly, perhaps with instruments not entirely suitable, but certainly without delay, the condition of the patient not permitting it. No previous preparation of the patient or preparatory treatment has been possible. His general condition is unknown. Septic elements are often—indeed, generally—present, not only upon the surfaces, but have, perhaps, been introduced deeply into the tissues by the trau-

matic cases, as circumstances permit or seem to indicate. The head may have already been opened before the case is seen by the surgeon, who is forced to do patchwork.

In operations for pathological conditions the reverse of what has been said exists. The proper time is chosen; all things are prepared beforehand; the proper light is provided; asepsis is secured; there is a due regard for both local and general cleanliness; the condition of the internal organs has been learned, and they have been made to functionate properly; a well and carefully con-



Horsley's cyrtometer.

matism for which the operation is undertaken, and infection may have already occurred within the head. The condition of the kidneys may be unknown to the surgeon; for, even though the urine be examined immediately after the injury and before the operation is undertaken,—and this should always be done,—yet, if the patient has been transported a certain distance in cold weather, or the surface of the body has been largely uncovered, as is not unusual after an injury, albumin may generally be found, and possibly also casts. The details in operative work, also, are often obscure, and landmarks obliterated, both within and without the skull. The head is opened, in trau-

sidered operative procedure is carried through after due study and consideration, and all necessary things are at hand. The operation then is undertaken in the best way for the patient's welfare.

An aseptic field of operation is pre-eminently essential to success. In cerebral surgery it is best that the whole head should be prepared and cleaned in all cases, unless of a very minor character.

In traumatic cases the head is to be shaved and the skin cleaned with green soap, hot water, nail brush, and carefully scrubbed. The ears should be cleaned out and filled with sterile cotton. The eyes should be closed with pads of sterile cotton. The

scrubbing should be done, not only upon the surface, but, if a wound exists, it should be scrubbed likewise, and an effort made to get out any dirt which has been forced beneath the skin; punctured wounds should be laid open; tracts beneath the skin should be opened and scrubbed; the edges of irregularly bruised tissue should be trimmed away and a clean surface obtained. When coal dust or grease has been forced beneath the surface, scrubbing with a nail brush and soap and washing with ether and alcohol will often be sufficient to obtain a clean surface. Dirt ground into the surface or edges of broken bone can be scraped away, or nibbled away with forceps, so as to be gotten rid of. After cleansing the head for traumatic operations a towel wrung out in **corrosive sublimate** solution (1:2000), or sterile water, perhaps, can be used as a cover for the prepared region until the instruments and other things are ready.

In preparing a patient for an operation undertaken for some pathological condition (not traumatic, of course) the patient is prepared a day before the operation, and then again just prior to the operation. As a prophylactic measure against meningitis Crowe has suggested the use of **methenamine**, which passes rapidly into the cerebrospinal fluid, imparting to it antiseptic properties; it is given in 5-grain doses or more 3 times daily, before and after operation. Blood-pressure readings should be taken, at frequent intervals, by a special assistant; a fall in the blood-pressure below 100 mm. should cause the operation to be interrupted temporarily, to be completed at another sitting. The head after being

shaved is carefully examined for scars, etc. It is disinfected with **soap and water**, **alcohol**, and **sublimate solution** (1:4000) the day before operation, and again at the time of operation. An **alkaline (sodium bicarbonate) solution** may be found useful to remove dandruff from the scalp, but Tiffany advised the use of **green soap**. Shaving and scrubbing with green soap, or a poultice of green soap applied over the surface after shaving and left on for a couple of hours and then scrubbing afterward, is efficacious. The green soap should be removed with alcohol, then ether, and the clean scalp tied up in a moist **corrosive sublimate dressing** until the following day; a repetition of the cleansing as already described gives a clean surface upon which to operate.

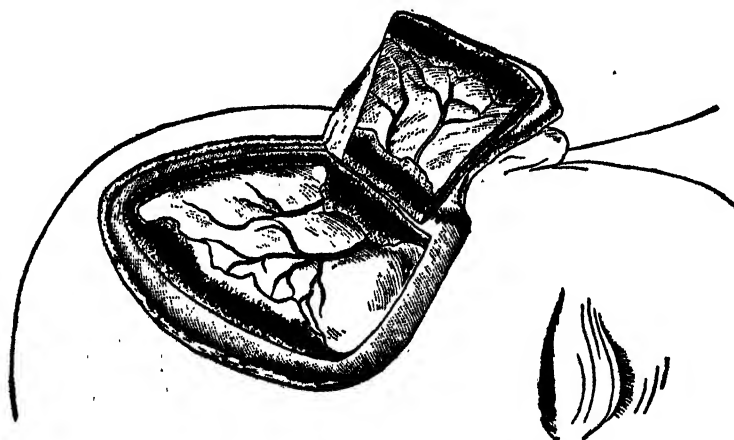
The dry scalp may be painted with a 5 per cent. **tincture of iodine**, which has become the most popular antiseptic measure in preparing the scalp for operation.

As the brain is to be covered in after the operation, a large horseshoe-shaped osteocutaneous flap with a diameter of about 3 inches, the base turned toward the source of the blood supply, is probably the most effective manner of uncovering the brain. It should be cut in one piece so as to permit of being turned down. This breaking down at the base is facilitated by cutting across the bone with sharp forceps, or otherwise, and it should be so cared for during operation that the skin and bone are not torn asunder; it may be necessary to envelop it in a cloth wrung out in hot, sterile, **salt solution**.

The patient being in the semirecumbent position, in order to dimin-

ish the amount of hemorrhage, the fissures—so far as desired—may be marked on the scalp with an aniline pencil; and also three points on the bone beneath—the point at which the center-pin of the trephine is to be applied, and the upper and lower ends of the fissure of Rolando at points just outside the flap; the center-pin of another trephine may be used for this purpose. The cutting of the bone is to be done by the instrument

As soon as the holes have been drilled a director with a beak turning off almost at a right angle, and grooved so as to properly direct a thin piece of whalebone between the dura and bone, is inserted with the beak placed between the dura and skull. The whalebone, threaded on the end with a long piece of strong and thin silk, is then pushed gently on in the direction of the other trephine opening until it comes into view, when the



Temporary resection of the skull. (Chippault.)  
(Gazette des hôpitaux.)

with which the surgeon is most familiar; the trephine, the rapidly revolving saw, chisel and mallet, the Gigli wire saw, all have their advocates. Should the opening not be large enough in the skull, there should be no hesitation to cut away the borders of the opening with rongeur forceps until sufficiently large.

The Gigli wire saw in resecting a portion of the cranium is used as follows: Having decided upon the outline of the three-sided flap which is to be turned down, two small incisions are made at the upper corners just sufficiently large to allow the application of a small trephine.

thread is partially drawn out. Each of the remaining sides of the flap is treated in a like manner. One end of the thread is attached to a wire screw, and the saw drawn through between the skull and the whalebone. The skin incisions are now completed and the bone sawed through.

There is a difference between the sides of the skull and the top; bone need not be put back into the temporal fossa, for, by reason of the presence of the dense temporal fascia, there is not much sinking in; it is otherwise at the top and front of the skull, as an absence of bone results in a deep depression. The time consumed in

exposing the brain is largely the result of the bone cutting. It is therefore a matter worthy of thought and careful consideration whether, when it becomes necessary to operate within the head, it may not be expedient to raise a large flap, remove the necessary bone, replace the flap, and allow it to heal. A month or two afterward the surgeon can operate to remove the pathological condition more rapidly, bone not obstructing.

**Trephining** *per se* is practically without risk, but the later development of paralysis, spurious meningocoele, epilepsy, and abscess is always to be considered. To the general surgeon, fractures with their concomitant brain injuries will always constitute the majority of cases in which operation is indicated. Here X-ray gives an assured estimate as to the damage to the skull, while a lumbar puncture will give an idea of the damage to the brain. Many basal skull fractures are doomed from the moment of the accident. In about 200 cases seen in the Cincinnati General Hospital, 37 per cent. of the deaths occurred in less than 6 hours, and 56 per cent. in the first 12 hours. The author can recall but 2 cases in which he believes that an operation foiled death in cases which appeared hopeless. In cases living longer, a spinal puncture will often accomplish all that a decompression will, and is destined to take its place in many instances, as it relieves the edema when the bleeding has stopped. **Decompression** is indicated in all cases in which the patients become progressively or suddenly worse, showing signs of increased intracranial pressure. Operations upon the cerebellum which were considered unjustifiable a little over a decade ago have been made quite as safe as pre-tentorial tumor operations, due partly to the fact that a large proportion of these tumors have turned out to be cysts requiring only drainage, and partly

because decompression promptly relieves the most distressing symptoms. Deaths due to respiratory failure must not be forgotten in this type of cases. J. Ransohoff (*Interst. Med. Jour.*, Apr., 1917).

In intracranial trauma, cerebral contusion and laceration present the most difficult problem from the standpoint of treatment, and are the most frequent cause of death. Their outstanding pathologic feature is cerebral edema with concomitant increase of intracranial pressure. Brain trauma so grave that without intervention death follows in 6 to 24 hours will not be influenced by a subtemporal decompression. Nor is decompression justifiable, it would seem, in cases of so moderate a degree of trauma that recovery is at no time in serious doubt. Even in the intermediate class one should discriminate.

The decision to operate must be made usually in the second 24 hours after injury, not before and seldom later, and must be based upon evidence of increasing pressure. Too much stress must not be laid upon single observations. The evidence should include a complete survey of the cerebral functions disturbed; stupor or unconsciousness, muscular relaxation, reflex disturbance, Cheyne-Stokes phenomena, and, as supplementary evidence only, the blood-pressure and papilledema. Even in properly selected cases, **subtemporal decompression** will not always tide the patient over. It is most effective where there is an excess of cerebrospinal fluid in the sub-arachnoid and subdural space, the opening of the dura allowing escape of fluid. It is least effective when there is no free fluid and the herniated brain engages snugly in the dural opening. C. H. Frazier (*Surg., Gynec. and Obstet.*, Jan., 1923).

It has been observed that opening the skull, even in incurable cases, may diminish pain and optic neuritis. The dura is to be divided and turned aside as a flap, the line of division being about one-third of an inch in-



ternal to the bone section, so as to allow of suturing and replacement. In general, the dura is to be respected and treated like other serous membrane, and with no more consideration. No antiseptic should be used after the dura is opened.

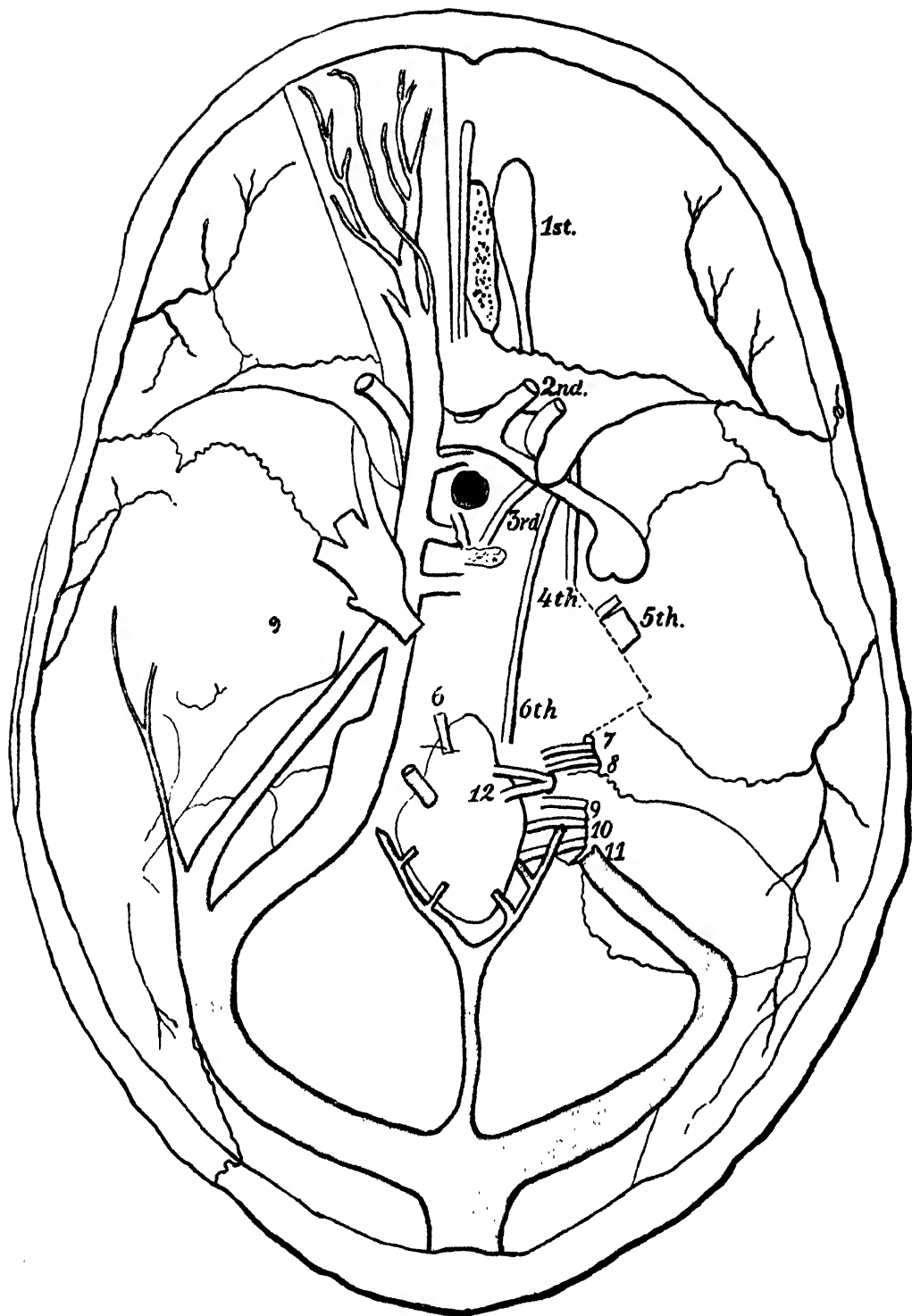
A decompression over relatively "silent" portions of the brain is now done only in the temporal and suboccipital regions, where muscle closure over the area can be made. Changes in the optic nerve-head observable by ophthalmoscopy are due much oftener to increased tension of the cerebrospinal fluid or direct pressure on the nerve by tumors in the region of the chiasm than to any other cause. Subtemporal decompression is employed not only as a temporizing measure in the presence of a localizable lesion, but is found of value in all unlocalizable cerebral tumors. An obstructive hydrocephalus can be determined by puncture of the temporal horn of the lateral ventricle through the subtemporal decompression opening. In the combined osteoplastic exploratory and decompression operation, with the bone flap so placed that its base is in the temporal region, the squamous wing of the temporal bone may be rongeuired away after the flap is reflected. The old 2-stage operations are called for less and less frequently. H. Cushing (Jour. Iowa State Med. Soc., Sept., 1921).

Hemorrhage from the skin may be arrested with hemostatic forceps. Encircling the cranium with a rubber band has yielded satisfactory results, especially by the Laplace tourniquet. A bandage is placed on the patient's head anteroposteriorly and laterally from ear to ear. An ordinary piece of rubber tubing is wound snugly four times around the patient's head. The bandage is then cut at the vertex, and the four strips which result serve to bind together the turns of rubber

tubing at the forehead, occiput, and both temporal regions. In this way the tourniquet cannot slip, and the strips of bandage enable the operator to have perfect control of the tourniquet and perfect hemostasis results.

Hemorrhage from the bone during the cutting may be arrested by **Horsley's aseptic wax** or **pressure with dry gauze**. By crushing in the edges of the bone with heavy forceps, by gauze pressure, or best by Horsley's wax (beeswax, 7; almond oil, 1; salicylic acid, 1), bleeding from the diploë may usually be arrested. In hemorrhage from the dura a fine **ligature** passed around the artery and tied suffices to stop bleeding. Venous hemorrhage may be arrested in the same manner. Hemorrhage from a sinus may be arrested in several ways: by **suturing** the wound in the vessels with a curved needle, passing the thread around it and tying it, and by **gauze pressure**. After turning the dura back and exposing the surface of the brain, bleeding vessels are to be looked for and tied carefully, without dragging, by two **ligatures**, and divided between. Forceps will generally tear off, and should not be employed, save very temporarily. **Serre-fines** may be of use.

The application of muscle strips to obtain hemostasis of the bone and venous sinuses is eminently effective and satisfactory. The technique is simple. A piece of any muscle sufficient for the purpose is cut. After rapid removal of clots with a tampon, it is placed on the bleeding point and pressed down firmly with the finger or any soft instrument. It adheres in a minute or so and stops the hemorrhage completely. It is applicable only to hemorrhages from bone or from the venous sinuses. E. Velter (Presse méd., p. 31, 1918).



Base of skull, showing the different fossæ, with nerves and smuses, which may be compressed by tumors.



Greater conservatism has been manifested of late in decompression for traumatic brain injuries. The writer warns, in particular, against operation in the presence of shock, manifested in hypotension, rapid pulse, paler and clammy skin. All depressed fractures of the vault should, however, be operated after shock has passed. Severe injuries cause a slow pulse and later a high and rising blood-pressure. Mydriasis and the pupillary light reactions are neither of diagnostic nor prognostic value, and unconsciousness is not of itself unfavorable. Brain contusion and laceration with shock symptoms cause a rapidly rising temperature, respiration and pulse, and nothing in a surgical way can be accomplished. Medullary compression and edema following brain injury show an increasing pulse rate, temperature and respiration to the moment of death. H. E. Randall (Jour. Mich. State Med. Assoc., Jan., 1924).

Attention called to subdural fluid accumulations, apparently of cerebrospinal fluid, frequently found in decompression operations. This fluid, probably having escaped into the subdural space through a tear in the arachnoid membrane, cannot be drained away by lumbar puncture because it is no longer in the subarachnoid space, and spurts out under great pressure at operation. Its removal by the decompression operation leads to rapid improvement where symptoms of high intracranial pressure have pre-existed. H. C. Naffziger (Jour. Amer. Med. Assoc., May 31, 1924).

In a case with evidences of intracranial hypertension the removal of enough spinal fluid to lower the pressure to 10 mm., repeated every 12 hours, may tide the patient through without operation. If, however, the pressure goes on increasing, subtemporal decompression is indicated, on the right side in the right-handed subjects and on the left in the left-handed.

Elevation of a depressed fracture should never precede the decompression

if the pressure attains 16 mm. T. M. Green (Intern. Clin., June, 1924).

In 497 cases of intracranial injury, death took place in 48 hours in 181 and later in 77. There were 232 deaths without operation and 26 following operation; 198 recoveries without operation, 41 following operation. Conners (Ann. of Surg., May, 1925).

Tumors within the brain will push up sulci from below, so that vessels can be tied more easily than in the normal brain. A growth should be encircled by ligatures under these circumstances. The material used in ligating varies. Some have used very fine sterile silk. Finally, there is that form of hemorrhage which may come from the exposed surface of a growth, and is usually denominated parenchymatous. Pressure with gauze will effectually arrest this. It may be that the gauze can be taken away at the end of the operation; usually it is to be left protruding and removed in two or three days.

In the absence of special indications for a certain anesthetic, chloroform has advantages, intracranial congestion being probably lessened thereby, while ether promotes hyperemia. The greater safety of the latter should, however, be borne in mind.

Some surgeons keep a cast of the brain at hand to refer to, while operating, for comparison with the exposed area. Electrical stimulation of the exposed area, by methods now well known, aids the operator.

When operating for a tumor of the brain which is covered by the cortex, the color and consistency of the exposed area may give information, but an incision will probably be of advantage. Certain growths have the same consistency as the brain, and

have been traversed by needles without recognition; hence color and consistency failing to be recognized, probably an incision into the brain is best; touch followed by incision, if the tumor does not present, is far better than touch followed by puncture, unless a cyst is discovered.

To expose the occipital region of the brain the writer advises the making of a flap of bone and scalp, with the base down. The bone flap approaches the middle line as far as is possible without danger to the longitudinal sinus. Upward it extends beyond the transverse sinus and laterally it exposes the sigmoid sinus. The flap having been turned down, the dura is cut just inside these vessels and also turned down. This exposes the cerebellum. Upon inclining the head to one side or the other the posterior surface of the petrous portion of the temporal bone is laid bare, and a small vein passing from the petrous sinus to the cerebellum should be ligated and severed. The lobe can then be carefully displaced with the brain spatula, and the facial and auditory nerve roots exposed. If, instead of pushing the hemisphere inward, one displaces it more upward, the roots of the tenth, eleventh, and twelfth nerves are exposed. Great care must be taken not to tear the pia or the ventral layer of the arachnoid. With care the entire posterior fossa can be explored and any extracerebellar tumors removed. If no lesion is detected by sight or touch, the cerebellum may be incised to a depth of an inch without danger. If, in spite of pressure symptoms, nothing is found, the fourth ventricle may be tapped to determine the existence of internal hydrocephalus. Krause (*Archiv f. klin. Chir.*, Bd. lxxxi, Nu. 1, 1907).

To gain access to the optic chiasm, hypophysis, and anterior pons region, the author opens up the sphenoidal sinus. This is easily done through the roof of the nasopharynx, pushing

the mucosa and periosteum apart, with the incision in the median line, and opening a passage through the body of the sphenoid. Before the operation a strip of cambric is passed through each nostril and out through the mouth and tied around the ears, thus holding the soft palate out of the way. The tongue is held down by a strip passed in through the pharyngotomy incision and out through the mouth, the ends being tied tight together over the chin. The instruments must have longer handles than usual and be a little stronger to work at the depth required. Löwe (*Zentralbl. f. Chir.*, April 10, 1909).

In many cases of tumor, the cortex is greatly displaced, but it is also probable that where the cortex is removed restoration of function, to a certain extent at all events, will follow. Circumscribed growths may be taken away by spoon, finger, knife, etc., but infiltrated growths, while they may be taken away, so far as can be recognized by the operator, give most unsatisfactory ultimate results, recurrence being the rule. The dura, being removed, should be replaced by gold foil, as advised by Beech, of Boston; or by rubber tissue, as practised by Abbe; or by a thin sheet of celluloid, as employed by McCoch; or egg-membrane (Freeman) to prevent adhesions between the brain and scalp, the advantages of which are that it is inexpensive and can be easily obtained, that it is not in the full sense of the term a "foreign body," and, though it ultimately becomes absorbed, it remains intact sufficiently long to accomplish the purpose for which it was inserted. There is, moreover, no danger of subsequent infection requiring a second operation and leading to extensive formation of connective tissue.

The free transplantation of fascia for dural defects has been particularly recommended. Kirschner found that such transplants remain alive. In carrying out this procedure, the fascia lata is exposed, the fat carefully removed from its surface, and a suitable piece excised and sutured to the edge of the dural defect with its muscle surface toward the brain.

Intracranial sutures may be of silk or fine catgut. To obtain a bone flap where it is thought necessary, when the natural bone is lacking, different expedients have been made use of: the periosteum from the tibia has been transferred to the head; the outer table of skull, while connected with the skin, has been fashioned as a flap to turn over and cover the defect; the removed bone, perforated with holes so as to permit of drainage, has been used; bone chips obtained by the use of the chisel or gouge on the adjacent sound bone have been placed on the dura, as a mosaic with the outer side downward. These are known as **autoplasty**. When a piece of foreign material, as silver, celluloid, decalcified ox bone, calcined ox bone, or aluminum, is used, it is called **heteroplasty**.

Rib grafts are obtained from the side of the chest, may be taken from 2 or 3 adjoining ribs if necessary, and are installed by inserting each end in a prepared slot.

Cranial deformities resulting from the destruction of frontal parts and especially the orbit arcade are easily corrected by **cartilaginous grafts**; the results are very satisfactory and seem perfectly stable. The pieces of cartilage used were obtained from subjects other than the one operated on. H. Morestin (*Bull. et mém. Soc. de chir. de Paris*, xlii, 333, 1916).

The indications for skull repair are rather obscure, but operation is justifiable in large pulsating defects with marked deformity. In heterografts where silver or celluloid is used, the defect of the internal table and the 5 to 8 mm. space above it still afford an internal hernia into which the brain may be forced by increased intracranial pressure. A chronic localized cerebral edema may thus be only slightly benefited, or not at all. The **auto-graft of rib cartilage**,  $\frac{1}{2}$  to  $\frac{3}{4}$  thickness of the normal rib, restores, on the other hand, the normal thickness of the bone and prevents any pinching. Localized cerebral edema will then gradually subside. In 5 cases of this type, the writer's results exceeded his most optimistic expectations. A. M. Hanson (*Milit. Surgeon*, Jan., 1922).

For the skin, sutures of silkworm gut are desirable. When the head has been opened for extensive operation, drainage is important. A piece of silver wire hooked in the lower angle of the wound, or horsehair or gauze may be used, or a small drainage-tube, to be removed after twenty-four or forty-eight hours, unless abscess develops, when it should remain several days. A voluminous dressing of sterile absorbent gauze secured by roller bandage or night cap will afford protection and support. The time when dressings are to be changed will vary with the conditions present. As a rule, half the stitches may be removed on the fifth or sixth day; the remainder by the seventh or eighth day. Absolute quiet of mind and body should be observed for the first week, and there should be no visitors, letters, or other disturbance for two weeks at least.

It was the failure to appreciate the importance of early wound excision, the evil effects of drainage and the

possibility of primary suture after excision that for so long kept the operative mortality in brain injuries above 50 per cent. during the war.

The operative technique then developed was complete **excision** of the scalp **wound**, avoiding contact with the lacerated edges, removal of the area of bone injury *en bloc* by cutting around it with a DeVilbiss rongeur, and not allowing the instruments to come in contact with the infected tissues in the center of the piece removed. Evacuation of disorganized brain substance was rapidly effected by having the patient cough or blow, after which a soft rubber catheter was inserted to palpate any retained foreign bodies or bone fragments already expressed. The early excision permitted immediate closure of the dura.

In ventricular penetrations it was found possible to insert long, narrow retractors and **remove foreign bodies** under direct inspection. When the ventricle was not involved and the toilet of the brain tract was completed, a 2 per cent. solution of **dichloramine-T** was usually introduced and allowed to run out during the completion of the operation. Large dural defects were covered with pericranium. The scalp was always closed by **primary suture**. The only **drainage** ever used was a small piece of rubber glove placed in one angle of incision and removed next day at first dressing. K. W. Ney (N. Y. Med. Jour., cx, 229, 1919).

#### INTRACRANIAL HYPERTENSION.

—Increasing attention has been paid to exact determination of the tension of the cerebrospinal fluid in traumatic and other brain conditions. According to Maclaire, the use of the spinal mercurial manometer is indispensable for the intelligent performance of brain operations. The pressure should be watched by repeated readings, *e.g.*, daily in traumatic cases and once or twice a week in brain tumors. There is no fear of medullary injury from release of pressure, for no fluid need be removed in the test.

**Lumbar puncture** has come into widespread use for both diagnostic and therapeutic purposes, as well as, at times, an indication for operative decompression. H. S. Stacy summarizes a widely held view in stating that in brain injuries, when a patient is unconscious for several hours, lumbar puncture is the best treatment, though in depressed fracture immediate operation is generally advisable, as also in suspected middle meningeal hemorrhage. The puncture, at the 4th lumbar space, is repeated every 6 hours, with the intervals lengthened gradually to 24 hours when the case is less severe. The amount withdrawn ranges from 20 to 30 or even 40 c.c. Under this treatment consciousness returns; 3 or 4 punctures usually suffice.

Traumatic brain conditions may advantageously be graded according to the existing degree or the absence of intracranial hypertension. Where increased pressure is found, the administration of **magnesium sulphate** by mouth, rectum or vein and, more particularly, the **intravenous injection of hypertonic** (15 to 30 per cent.) **sodium chloride solution** have proven serviceable. Rodman and Neubauer (Ann. of Surg., Apr., 1924) in cranial injury with the spinal pressure between 10 and 18 mm. Hg, a moderate rise in blood-pressure, temperature and pulse, and a normal respiratory rate, advise **rest in bed**, an **ice-cap**, **elevation of the head of the bed**, and repeated **lumbar punctures**, together with **intravenous injection of 60 to 80 c.c. (2 to 2½ ounces) of 15 per cent. hypertonic salt solution**, or **magnesium sulphate** by rectum.

In most cases of head injury of the type susceptible to gradual intracranial hypertension, it will suffice to give ½ ounce (15 c.c.) of saturated **magnesium sulphate** solution by mouth every 2 hours for 48 hours, the intervals thereafter being increased as the patient improves to final stoppage on the 7th to the 10th day. If, nevertheless, bilateral choked discs, etc., develop, an intravenous injection of 50 c.c. (1½ ounces) of 30 per cent. **sodium chloride solution** is indicated, followed by intravenous injection of 10 c.c. (2½ drams) of **magnesium sulphate solution**. J. C. Weaver (Surg., Gyn. and Obst., Sept., 1925).

**SURGERY OF THE LATERAL VENTRICLES.**

—A number of cases have been reported in which the lateral ventricles have been opened by injury, 5 cases from simple cranial fracture occurring in children, of whom 3 recovered. There are also recorded 7 cases of compound fracture with injury of the ventricles, in which 4 of the patients recovered, and 2 cases of primary rupture of the ventricles by compound fracture, in which both patients recovered. In fungus cerebri a communication with the lateral ventricles is sometimes established, manifested by a continuous flow of cerebrospinal fluid therefrom, in which recovery has followed. Keen has shown, moreover, that puncture of the lateral ventricles through the brain substance can be done accurately, and that a drainage-tube may be introduced into the ventricles and remain several weeks without inducing encephalitis or meningitis, and that even irrigation of the ventricles from side to side after bilateral trephining can be done without discomfort to the patient. From these facts it follows that in cranial fractures involving the ventricles we should not consider the accident as necessarily fatal, but should employ the same antiseptic precaution, methods, and treatment as though the ventricles had not been involved, and with a reasonable hope of recovery.

If the ventricles are to be tapped, Keen advises the lateral route. A  $\frac{1}{2}$ -inch trephine opening should be made  $1\frac{1}{4}$  inches behind the external auditory meatus and the same distance above Reid's base line (an imaginary straight line drawn through the lower edge of the orbit and the

meatus auditorius externus). Then the grooved director or a small tube (caliber No. 5 of French catheter scale, or a little larger) should be thrust carefully and steadily into the brain in the direction of a point  $2\frac{1}{2}$  to 3 inches above the opposite meatus. If the lateral ventricle is of normal dimensions, says Keen, it will be reached at a depth of 2 to  $2\frac{1}{4}$  inches, but if distended it will be reached at a less depth. The entry into the ventricle will be recognized by the instantly diminished resistance and also by the escape of cerebrospinal fluid. Drainage, either by inserting a small bundle of horsehair doubled like a hairpin, with the rounded ends inserted first, and passed through the tube, or by carrying a rubber drainage-tube of the same size into the ventricles. Asepsis must be absolute, or the result will be necessarily fatal.

This operation has been done for the relief of acute hydrocephalus with promising results (Mayo Robson reports a cure); in chronic hydrocephalus several operations have been done, but without success.

**Ventriculography.**—This procedure, suggested by W. E. Dandy, consists in removing somewhat more cerebrospinal fluid than the contents of one or both lateral ventricles, replacing it with an equal amount of air, and taking X-ray pictures. Before the fontanels close the ventricular puncture is made through the interosseous defect; later a small opening in the bone is made. The posterior horns are tapped. The head is placed face downward and partially rotated so that the ventricle to be aspirated is beneath and the needle enters at the most dependent point possible. To obtain accuracy a Record syringe with 2-way attachment is used. A small quantity (20 c.c.) is first aspirated and an equal amount of air injected. This is repeated until somewhat more than the contents of the ventricle has been removed. Dandy has in-



jected from 40 to 300 c.c., the latter in internal hydrocephalus. Invariably the lateral ventricle is sharply outlined in the X-ray picture. The method has proven useful in diagnosis, particularly in brain tumor and in internal hydrocephalus.

Two types of reactions may follow air injection, due (1) to an increase in intracranial pressure; (2) to bulbar irritation or paralysis. Slow replacement of fluid by air to avoid sudden change of tension, removal of the air after the X-ray views have been made, and the exhibition of hypertonic solutions should all be employed to combat these dangers. The procedure should not be employed unless neurologic examinations prove indeterminate. W. Penfield (*Arch. of Neurol. and Psych.*, May, 1925).

**Puncture of Corpus Callosum.**—As described by Von Bramann and Anton, a small trephine opening is made behind the coronal suture and a cannula introduced down to the falx cerebri and along this to the corpus callosum, through which the tip of the cannula is pushed. This opens a passage for the cerebrospinal fluid from the ventricle into the subdural space and thus reduces the fluid pressure in the ventricle.

**CEREBRAL CONCUSSION.**—It is very difficult to establish clinically a distinction between concussion and contusion of the brain. However, concussion conveys the idea of the brain, as a whole, having been violently shaken under the effect of a traumatism, resulting in a disturbance of function, without any appreciable lesion of the brain substance. The boundary between the two conditions must, therefore, be more imaginary than real.

In the mildest grade of concussion there has been asserted to occur a brief diminution of the blood-pressure in the part; its tension is temporarily lowered. If the violence is somewhat greater, there is superadded a disturbance of the cellular

constituents composing the surface of the brain. A disturbance or disarrangement of the molecular elements of these cells, even though it be microscopically minute, must suffice to induce functional derangement. As the violence is increased the effects are correspondingly greater, and may even reach that point where the functions of life cease at once owing to bulbar paralysis. In the severe form there are lacerations of the brain tissue and blood-vessels. These lacerations may give rise to hemorrhage in such amount as to produce symptoms of compression.

**SYMPTOMS.**—These vary from temporary giddiness to collapse and death. In a typical case there is unconsciousness, but the patient may be partially aroused by shouting, or pricking the soles of the feet with a needle. Relaxed muscles, cold and pale skin, subnormal temperature, slow and shallow respirations, weak and rapid pulse, dilated pupils equal in size and reacting to light, sluggish or absent reflexes; relaxed sphincters, causing involuntary bowel movements, but retention of urine from relaxed bladder muscle, mark the typical case. Transient paralyses if present mark the stage of collapse, which may last from a few minutes to hours, and end either in death or in reaction, which may be preceded by a convulsion or more commonly by slight movements of the extremities and vomiting. The symptoms in the latter case gradually disappear, the temperature rises, perhaps to 100° F. or slightly higher, and headache, drowsiness, or irritability appears and may persist for several days.

Miles demonstrated in experiments that there is a temporary anemia of

the brain in concussion. This is the reflex result of the stimulation of the restiform bodies, and perhaps other important centers in the region of the bulb. These parts are stimulated by the cerebrospinal fluid, which rushes through the aqueduct of Sylvius, the foramen of Magendie, and the sub-arachnoid space when a severe blow is dealt over the head. Therefore, this cerebrospinal fluid will disturb the equilibrium of the ultimate nerve cells throughout the nervous system.

**PROGNOSIS.**—This should be guarded, although complete and permanent recovery usually follows. The early dangers are compression from hemorrhages, and inflammation of the brain or meninges. The possible sequelæ are cerebral irritability, inveterate headache, vertigo, loss of memory, change in character, insanity, epilepsy, diabetes, neurasthenia, and more rarely tumor or abscess. The patient's memory is frequently defective for the events immediately preceding the accident.

Trench warfare has developed a serious and almost unvarying concussion syndrome. In 168 cases the writer established 6 different groups: 12 cases of mutism with or without deafness and with or without true auditory lesions. Most of the cases of uncomplicated mutism recovered spontaneously or under re-education and reassuring words; 21 of painful concussion with frontal headache persisting for months, mental depression preventing sustained work, slight dizziness, unsteadiness in the standing position, and unilateral deafness, slowly recovered from; 17 cases of labyrinth concussion of all grades, from a simple dazed condition to marked ataxia and astasia abasia; 54 cases of the typical concussion syndrome, characterized by mydriasis

persisting from 2 weeks to several months. H. Aimé (*Presse méd.*, Feb. 22, 1917).

**TREATMENT.**—During the stage of collapse apply **external heat** and give **stimulants**, alcohol being, however, interdicted because of its exciting effect on the brain. Overstimulation should be avoided. When reaction begins, the patient should be kept in bed, **absolute quiet** maintained, an **ice-bag** placed on the **head**, the **bowels purged**, and the **catheter** used if there is retention of urine. **Sedatives** may be prescribed if necessary. A **liquid diet** is best in these cases.

A very important factor in the after-treatment of cerebral concussion is to order the patient **absolute and prolonged rest**, whether the concussion has been severe or only slight. He should abstain from all business or worries of any kind. The best plan is for him to go down to a little country place, and avoid all excitement. Health resorts are not calculated to afford the mental rest which is so needful. See also **CEREBRAL ABSCESS, NERVOUS SYSTEM: ENCEPHALITIS, and FRACTURES.**

### **CEREBRAL CONTUSION AND LACERATION.**

A contusion of the brain always accompanies any serious injury to the the cranium. Such contusion can exist without necessarily having a fracture of the skull; but on the other hand, a fracture of the skull is always accompanied by cerebral contusion.

**SYMPTOMS.**—The symptoms of contusion of the brain, referring to loss of function, are characterized by their diffuse or generalized condition. Hence, they differ materially from those of compression, which refer

absolutely to distinctly localized lesions. Vomiting often occurs after the injury. Respiration is superficial, but may be deep and stertorous. Fever has been observed in contusion of the brain, especially in case of injury or irritation of the median portion of the corpus striatum, and the mesencephalon, such as the posterior corpora quadrigemina and the sensory nucleus of the fifth nerve (Kocher).

It has long been a mooted question whether contusion could always be differentiated from concussion of the brain by any special symptom. Clinically this does not exist. In a general way the symptoms of concussion, resulting from a lighter form of traumatism, produce less material disturbance and are therefore more transitory, whereas in severe contusion the symptoms persist and are sometimes aggravated, because of the possibility of an encephalomeningitis complicating the case. Loss of consciousness, partial or complete. Paralysis more or less complete of different portions of the body. A cold, clammy condition of the skin. A feeble, fluttering heart. After a few days these symptoms disappear gradually, depending upon the absorption of the extravasated blood. After recovery the patient may suffer for a time from vertigo, headaches, and loss of memory, in addition to a general debility and malaise.

Edema may arise in contusion or laceration, gradually creating brain compression. Severe cortical laceration causes twitching or convulsions, or the patient may lie with his legs drawn up, resisting manipulations.

**PATHOLOGY.**—Contusion does not necessarily bear a direct relation

to the seat of injury. Bergmann maintains that when the traumatism has been applied over a large area, and violent enough to depress the skull, not only is there severe contusion, or laceration of the subjacent brain structure, but the corresponding portion of the brain on the opposite side has likewise undergone considerable contusion, by the force being transmitted through the brain, against the skull, opposite the seat of injury.

The superficial layers of the brain are most likely to be affected, especially since the gray cortical substance is the most plentifully supplied with blood-vessels. In fractures at the base of the skull contusion of the brain exists mostly at the temporo-sphenoidal lobes. The occipital lobes are not so readily affected, on account of the protection offered them by the cerebellum. The following distinction exists between a spontaneous cerebral capillary hemorrhage and that resulting from a contusion, viz.: In contusion the arachnoid is likewise a seat of hemorrhage, owing to its share in the effects of the traumatism, while in spontaneous cortical hemorrhage the meninges are not affected.

According to the violence of the injury will the character of the capillary hemorrhage, destruction of tissue, and corresponding impairment of function vary. The hemorrhage might be disseminated and punctiform, or more pronounced, giving a dark area with lighter boundary. Such a lesion as this, if examined microscopically, would give evidence of minute destruction of cerebral substance by the blood disseminated in the tissues.

In general, such a condition will tend toward a process of absorption and gradual restoration of impaired function, provided there is no infection, either directly, because of the traumatism, or indirectly, on account of a latent systemic infection which could, perhaps, implant itself in this locality.

The patient may, however, be exposed in addition to the harmful effects of hemorrhage from the pial arteries between the gray and white matter of the brain. According to Apfelbach, such an extravasation may dissect its way out through the friable gray substance toward the periphery. The delicate strands of tissue surrounding the Pacchionian bodies and supracortical veins are thus destroyed, failure of absorption of cerebrospinal fluid results, and as the choroid plexus continues to secrete, intracranial pressure rises, cerebral edema occurs, and there is observed clinically a condition of cerebral and medullary irritability, followed by compression and collapse.

In brain laceration, blood is almost always present in the subarachnoid space. Even a small area of contusion may give rise to an extensive hemorrhage. Since blood in the subarachnoid space is easily detected through lumbar puncture, this procedure is obviously of diagnostic importance in suspicious cases.

(See NERVOUS SYSTEM: ENCEPHALITIS, and CEREBRAL ABSCESS.)

**PROGNOSIS.**—The prognosis depends upon the occurrence or absence of compression from hemorrhage or edema and upon the presence or absence of infection. Should no disturbance occur from these causes, a gradual recovery is to be anticipated.

On the contrary, should the brain tissues have become infected, one may expect encephalitis and its results.

**TREATMENT.**—The following measures are in order: **Complete rest**, with the **head slightly elevated**. The depression may be relieved by hypodermic injections of **strychnine sulphate**,  $\frac{1}{40}$  grain (0.0016 Gm.) every three hours until the pulse reacts. **Hot-water bags** are applied.

As soon as the patient is able to swallow, he should be given **purgatives** (*e.g.*, enough **magnesium sulphate** to produce a number of watery evacuations daily), which will, by depleting the circulation, promote the absorption of effused serum.

Should there be the slightest abrasion or wound of the scalp, even if unaccompanied by fracture of the skull, the strictest **antiseptic precautions** should be maintained, lest an infection from without provoke meningitis.

Evidences of beginning intracranial hypertension may be met by repeated **lumbar punctures**.

If the symptoms are much aggravated in a few days, showing cerebral edema, the indication is to **trephine** over the seat of the injury and if necessary **incise the dura** for the relief of intrameningeal pressure.

The trephined opening may be enlarged by means of the rongeur forceps, if the size of the contused area warrants the procedure; it is remarkable how much drainage of fluid takes place under the circumstances, followed by gradual disappearance of the pressure symptoms.

In 397 cases of skull contusions, during the war, the writer found **lumbar puncture** a valuable aid in treatment

of severe contusion of the brain or spinal cord from explosion of a shell or mine. The fluid keeps under high pressure for days and the patients exhibit paralytic phenomena or melancholia with stupor or Jacksonian epilepsy. Leriche (Lyon Chir., Sept., 1915).

### **SUBDURAL HEMORRHAGE.**

This hemorrhage generally occurs from the rupture of a number of small vessels, or of one large vessel (especially the middle cerebral), the extravasation being under the dura.

**SYMPTOMS.**—These are much the same as in extradural hemorrhage (*q.v.*) or brain compression in general, but are usually very prompt in onset. Lumbar puncture is likely to yield bloody fluid.

**ETIOLOGY.**—This hemorrhage occurs most frequently as a result of depressed fracture. A few cases have been reported as due to pachymeningitis interna, which cases should be treated by trephining, evacuation, and drainage.

**PATHOLOGY.**—The patient often dies from direct injury to the brain. If he recovers, the clot, having produced more or less paralysis, is gradually absorbed, but the brain may not expand to its former position, being permanently depressed, the site of the injury being sometimes occupied by spongy connective tissue, the meshes of which are filled with cerebrospinal fluid, resembling a series of cysts. The paralysis will gradually lessen and may almost entirely disappear, but, after a period of from a few months up to two or three years, epileptic or other cerebral disturbance may appear and persist through life.

**TREATMENT.**—The treatment is the same as for extradural hemorrhage. The anterior trephine open-

ing, therein referred to, is enlarged upward and backward, giving access to the middle cerebral arteries, and, if symptoms indicate intracranial hemorrhage, and no clot is found under the bone on trephining, the dura should be opened and the clot searched for along the fissure of Sylvius, in which the middle cerebral lies, and the bleeding-point must be found, if possible, and the artery tied.

**Lumbar puncture** advised in traumatic subdural hemorrhage in the newly born. If this fails, a small **decompressive trephining** of the space below the tentorium back of the mastoid process is suggested. Henschen (Archiv f. klin. Chir., xcix, 1, 1912).

### **CEREBRAL HEMORRHAGE.**

See CEREBRAL HEMORRHAGE, Vol. III.

### **COMPRESSION OF THE BRAIN.**

This is a not uncommon condition in injuries of the head, arising from various causes. In whatever way this condition is brought about, from the pressure of extravasated blood, of pus or other inflammatory exudate, of a depressed portion of bone from fracture or new growth, or from a foreign body lodged there, the symptoms, although presenting some differences, are, as a rule, constant.

In compression from depressed fracture, foreign bodies, and apoplexy the onset of the symptoms is immediate; in middle meningeal hemorrhage and in inflammatory exudates it is delayed, while in tumors, cysts, and chronic hydrocephalus it is very gradual. The symptoms may be preceded by or mixed with those of concussion in traumatic cases. The degree of pressure when localized determines either irritation or paralysis of the affected center.

In generalized compression the symptoms, when the condition develops gradually, are those of irritation, and, as the pressure increases, those of paralysis of the cortical and lastly the bulbar centers. Headache, vertigo, restlessness, delirium, convulsions, vomiting, tinnitus, contracted pupils, and choked disk mark the first stage, to which are added a slow, full pulse; elevated blood-pressure, rapid and deeper respirations, from stimulation of the vagus, vasomotor, and respiratory centers. Trauma, hemorrhage, and shock lower the temperature; lesions of the pons and medulla and inflammatory conditions raise it.

In the second stage the patient lies in a state of lethargy, stupor, or coma, more or less completely paralyzed, heavy, insensible, and drowsy, either not responding when addressed or only when spoken to in a loud tone of voice, and perhaps only when violently shaken. The respirations are slow and deep, with stertor or snoring, and usually a peculiar blowing sound. Paralysis of the velum palati, which, hanging down as a curtain, is thrown into vibrations during expiration, seems to cause the stertor; the distention of the cheeks and the blowing sound are due to muscular paralysis of the lips and cheeks. The pulse is full and often slow; one or both pupils are dilated; paralysis of the sphincter ani causes involuntary evacuation of the feces, and paralysis of the bladder generally causes retention of the urine; the skin may be cool, but is, in many cases, rather warm and covered with perspiration. Frequently the condition of stupor alternates with paroxysms of delirium or of local convul-

sive action. This condition of coma may be complicated by the appearance of symptoms of inflammation.

Unless the cause that produces the compression is removed, death quickly follows, the coma deepening and the patient dying in an apoplectic condition from respiratory failure, the heart continuing to beat for some minutes after breathing has stopped. In rare cases the coma may continue for many weeks or months, until the cause of compression is removed, when consciousness returns and symptoms suddenly disappear.

**TREATMENT.**—**Operation** is called for by focal symptoms and by a depressed or compound skull fracture. Intervention should be withheld until shock has passed off.

Where there are no focal symptoms and compression is but moderate, indirect measures may be employed for a time. Thus, **lumbar puncture** may be done repeatedly. Another valuable procedure is to inject intravenously 50 to 150 c.c. ( $1\frac{1}{2}$  to 5 ounces) of 15 per cent. **sodium chloride** solution in the course of 20 minutes, this measure lowering pressure for a few hours by withdrawing fluid from the cerebral ventricles. **Magnesium sulphate** solution may be given by rectum to keep up the effect. (See also *ante*, under INTRACRANIAL HYPERTENSION.)

If symptoms increase and the spinal pressure steadily mounts, without localizing symptoms, **subtemporal decompression** is indicated.

#### **TRAUMATIC INTRACRANIAL HEMORRHAGE.**

Extravasation of blood commonly occurs in all injuries of the head accompanied by laceration of the brain, and in many in which the skull is

fractured and the brain uninjured. Intracranial hemorrhage is favored by the great vascularity of the parts within the skull, the large sinuses, the numerous arteries that ramify both within the bones and at the base of the brain, and the intricate vascular network extended over the surface of the brain.

The extravasation may occur in three situations: Between the dura mater and the skull (extradural); between the dura mater and the brain (subdural); within the brain substance and its ventricles (cerebral).

### EXTRADURAL HEMORRHAGE.

This form of hemorrhage is also called *meningeal extravasation*, as it most commonly arises from rupture of the middle meningeal artery or its branches, which, from its location in a deep canal in the parietal bone, is peculiarly liable to rupture in injuries of the side of the skull.

**SYMPTOMS.**—The symptoms of extradural hemorrhage are those of compression, divisible into three stages: concussion, a return and some continuance of consciousness (pathognomonic of this condition), and then coma, gradually supervening. The patient is at first stunned by the accident; from this he quickly recovers and then relapses into unconsciousness, which gradually increases in intensity. He becomes dull and sleepy, with a slow, laboring pulse; dilated and sluggish pupils, and a tendency to slower respiration. As the compression increases, complete stupor supervenes, with stertorous breathing, and the appearance of either general paralysis or hemiplegia of the side opposite to the injury.

**DIAGNOSIS.**—The diagnosis of this and the following (subdural) form of hemorrhage from the *cerebral* form is important, as no operative interference in the latter case would be successfully undertaken, for the reason that the injury to the brain substance is usually so extensive that, even were the clot removed, the patient would die from the injury. Attention to the symptoms of each variety will usually be sufficient to differentiate them.

The diagnosis between compression from *extravasation* and that from *depressed bone* or *inflammatory effusions* within the skull is generally easily made. In depressed fracture the compression symptoms continue uninterruptedly; examination will reveal the injured bone. Compression symptoms due to inflammatory effusions are preceded by symptoms of cerebral inflammation, and are accompanied by a strong febrile movement, accelerated pulse, and hot skin; the character of the scalp wound and the separation of the dura mater when pus is effused distinguish this form from that in which the pressure is the result of extradural or subdural hemorrhage.

From apoplexy differentiation is not easy. From drunkenness, the absence of injury, the odor of the breath, and the flushed and turgid face would point to alcoholic intoxication.

In opium narcosis the pupils are strongly contracted, instead of being widely open, as in coma from cerebral compression.

**ETIOLOGY.**—Extradural hemorrhage may occur with or without fracture of the skull. When the result of fracture, it is caused by the

fissure tearing across the meningeal artery or more often one of its branches distributed on the interior of the skull, or a fragment of bone wounding a sinus or the vascular network on the cerebral surface.

**PATHOLOGY.**—The blood that is extravasated usually coagulates into a firm, granular clot. This clot may be absorbed entirely; the serous portions and coloring matter may become absorbed, leaving a fibrinous, buff-colored clot, which may become organized; and finally the exterior of the clot may become organized, while the interior may contain fluid and disintegrated blood.

**PROGNOSIS.**—The mortality of these cases treated upon the expectant plan (without operation) is very high. Wiesmann reports 147 cases treated expectantly, with 131 (89.1 per cent.) deaths, while, of 110 cases operated on, only 36 (32.7 per cent.) died, and in the majority of the fatal cases the extravasation was not reached and the clot therefore not removed.

**TREATMENT.**—Operative treatment should be resorted to as soon as the diagnosis has been clearly made. The localizing symptoms should determine the spot to be trephined. Krönlein has shown that, in the greater number of cases, the clot will be most easily reached by **trephining**  $1\frac{1}{4}$  inches behind the external angular process at the upper level of the orbit. If the clot is not found by this opening we may trephine just below the parietal boss, on the same level with the former opening. The main trunk and the anterior branch of the middle meningeal artery are reached by the anterior opening, and the posterior branch by the posterior open-

ing. If the clot be discovered it should be removed, enlarging either trephine opening, if necessary, by the rongeur forceps. If the pupil be dilated, showing that the clot is gravitating downward toward the base, the trephine opening should be made near the first point, but about  $\frac{1}{2}$  inch lower. After the clot has been scooped out gently, the cavity should be washed out with sterile saline solution at body temperature. If the artery is still bleeding, a semicircular Hagedorn needle armed with catgut should be passed through the dura, under the artery, and out again through the dura on the other side of the artery, and the artery tied. Other measures that may be employed for arresting hemorrhage are **packing, silver clips, and plugging the foramen spinosum.** **Drainage** should be provided unless the circumstances warrant primary closure.

In injuries to the cranium or its contents, lumbar puncture with spinal fluid pressure observations are essential to proper management. In operating in extradural hemorrhage, the dura should not be opened unless there is a marked rise in blood-pressure and spinal pressure with blood in the spinal fluid. The possibility of meningitis or encephalitis increases from less than 5 per cent. in the unopened cases to 15 to 25 per cent. in the opened ones. In all of the writer's cases of head injury in which **débridement** was done, primary union followed—a decided improvement over pre-war days when a drain was inserted in cases of doubtful nature.

Case of a man struck in the mid-temporal region by a large piece of coal. He sustained a scalp laceration with compound depressed fracture and extradural hemorrhage. He walked into the operating pavilion with no evidence of intracranial hypertension except an increase in blood-pressure



(systolic 155, diastolic 85). **Débridement** and complete closure. A small **drain** inserted to control hemorrhage; removed in 12 hours. Primary union followed and there were no complications. J. O. Bower (Ann. of Surg., Oct., 1923).

If there is a rapid increase in intracranial pressure, as from hemorrhage, in the first 3 to 12 hours after injury, there will be first a slowing of the pulse rate and a rise in the systolic and pulse pressures. Later, if not relieved, a rise of the pulse rate and fall in systolic, with high pulse pressure, will result from fatal pressure transmitted to the medulla. To save life before the pulse rate begins to rise or the systolic pressure drops, a prompt **subtemporal exposure** is required. It would be useless to temporize with a spinal puncture in such a case. J. G. Lyerly (Va. Med. Mthly., Feb., 1924).

In children several days of consciousness may elapse before pressure symptoms develop. They should therefore be closely observed when the type of injury suggests the possibility of extradural hemorrhage. J. C. Weaver (Surg., Gyn. and Obst., Sept., 1925).

**ABSCESS OF CEREBRUM AND CEREBELLUM.** See CEREBRAL ABSCESS.

### **INFECTIVE SINUS THROMBOSIS.**

This is usually secondary to infections of the ear, nose, pharynx, face, orbit, or scalp, the primary inflammation spreading by contiguity, or by setting up a phlebitis which extends inward to the sinuses. Middle-ear disease is the cause in two-thirds of the cases and the lateral sinus is the one affected. Primary infection may arise in compound fractures of the skull or in acute infective fevers. Meningitis and brain abscess are frequent complications.

**SYMPTOMS.**—These arise from the infective fevers and from the thrombosis. The infective symptoms are similar to those of septicemia or more often pyemia; some cases simulate typhoid fever; in others pulmonary symptoms are present, due to infection of the lungs with emboli. If the meninges become infected, there will be cerebral irritation or compression. The thrombotic symptoms vary with the sinus affected. In thrombosis of the *lateral sinus* there are pain, tenderness, and edema along the line of the sinus, over the mastoid and along the jugular, if invaded. There is usually a history of suppurative middle-ear disease with offensive discharge which has ceased with the beginning symptoms of sinus thrombosis. The pneumogastric, glosso-pharyngeal, and spinal accessory nerves may be paralyzed by pressure in the jugular foramen. In thrombosis of the *superior longitudinal sinus* there are pain, tenderness, and edema along the sinus and over the forehead, epistaxis, and perhaps convulsions from irritation of the motor area. In thrombosis of the *cavernous sinus*, there are exophthalmos, edema of the orbit and eyelids, choked disc, and paralysis of the third, fourth, ophthalmic branch of the fifth and sixth cranial nerves. There are no localizing symptoms in thrombosis of the *petrosal sinus*.

**TREATMENT.**—In thrombosis of the *lateral sinus* due to middle-ear disease, the **mastoid** should be **opened and cleaned out**, and the **sinus exposed** by gouging or chiseling the bone at the posterior part of the opening. **Remove any pus** in the groove of the sinus, and confirm the diagnosis by palpating the sinus and by

aspirating its interior. After confirming the diagnosis the internal jugular vein should be tied below any existing thrombus to prevent septic dissemination. **Open the sinus**; remove the clot with a **curette** until blood flows freely. Gauze forced between the sinus and the bone will control this bleeding. If the jugular is involved excise it above the ligature and irrigate from the opening in the mastoid through to that in the neck. Pack both wounds with **sterile gauze**. The mortality after operation is about 50 per cent.; without operation practically all cases die. Thrombosis of the *longitudinal sinus* is treated in a similar manner; the remaining sinuses are practically inaccessible.

### WOUNDS OF THE SINUSES OF THE BRAIN.

The superior longitudinal or the lateral sinuses are occasionally injured during the course of operations, but more often in cases of severe fracture of the skull, usually of the compound variety. When a sinus is injured the extravasation of blood is so rapid and copious that the patient may die in a few minutes from shock, as rapid loss of blood from the brain is more fatal than a like loss in other situations. Hence the necessity for great care when operations are made in the neighborhood of the sinuses. In using the trephine the edge of the instrument should be placed at a perfectly safe distance. The dura may be separated and the sinus entirely detached from the skull by using the dural separator, or a grooved director or probe, and then the finger. The rongeur forceps may then be safely used to enlarge the

opening made by the trephine. If incision or exsection of a portion of the sinus is necessary, the sinus may be exposed and ligated on both sides of the proposed incision or exsection. If the sinus be opened accidentally during operation or by fracture, **lateral ligature** and **suture** of the sinus may be employed, the former being less difficult and dangerous than the latter, but only applicable to small wounds; instant packing with **iodoform gauze** will, however, arrest such hemorrhage. It has also been suggested that the margins of the wound be secured by one or more pairs of **hemostatic forceps**, which may be removed on the second or third day.

### INFLAMMATION OF THE BRAIN AND MENINGES.

Intracranial inflammation may involve the dura (pachymeningitis), the arachnoid and pia (leptomeningitis), or the brain (encephalitis). Under this general head we should include infective sinus thrombosis. See also MENINGES AND BRAIN, DISEASES OF.

**Pachymeningitis Externa.**—Inflammation of the outer layer of the dura mater may be due to trauma, syphilis, or to diseases of the cranial bones, especially the bony tissue enveloping the middle ear. In the *simple* form the dura is thickened and may cause a persistent localized headache. In the *suppurative* form pus collects between the dura and the bone. The symptoms and treatment are those of extradural abscess. See also MENINGES and BRAIN, DISEASES OF.

**Pachymeningitis Interna.**—This may be due to extension from the outer layer of the dura or from the pia and arachnoid. When the

vessels of a vascular layer, which forms on the inner surface of the dura, ruptures it is called *pachymeningitis interna hæmorrhagica* or *hematoma of the dura mater*. This affection is generally bilateral, and occurs most frequently in the insane, alcoholic, syphilitic, and in the aged, but may complicate infectious fevers and diseases of the blood. The symptoms are those of cerebral irritation and slowly progressing compression, occasionally presenting localizing phenomena. Treatment consists of **trephining** on both sides and **removing the subdural clot**. See also MENINGES AND BRAIN, DISEASES OF.

**Leptomeningitis.**—Inflammation of the pia-arachnoid may be acute or chronic, localized or diffused. The acute form may be primary, due to pyogenic organisms of wounds or to *Diplococcus intracellularis meningitidis* of epidemic cerebrospinal meningitis. Most commonly it is secondary to infective diseases of the scalp, cranium, and face (erysipelas, carbuncle, caries, necrosis, and middle-ear disease), or to pyemia, pneumonia, typhoid, influenza, diphtheria, gonorrhea, anthrax, actinomycosis, tuberculosis, or sun-stroke. It may occur as a terminal infection in many chronic diseases, including chronic alcoholism (pyogenic organisms). The subarachnoid space becomes distended with a cloudy or purulent fluid, and the brain becomes edematous and covered with lymph, and often is the seat of small hemorrhages. The inflammation generally extends to the meninges of the cord. The symptoms in traumatic cases usually appear within two or three days, although they may be delayed as a result of delayed infection by way of

the blood- or lymph- vessels. The symptoms are those of sepsis, of cerebral irritation, and of cerebral pressure. Upon lumbar puncture the cerebrospinal fluid spurts out, being under great pressure; it contains many polymorphonuclear leucocytes in septic cases, many lymphocytes in tuberculous cases, and the specific bacteria of the several causative diseases. **Trephining** for drainage is indicated if the process is localized, the opening being made in the occipital bone at the base of the brain. Chronic leptomeningitis is not infrequently met with in syphilitics and alcoholics, but may also be traumatic in origin. The membranes become thickened and adhere to the brain, giving rise to persistent localized headache, tenderness, and, at times, epilepsy. When medical treatment (**sedatives** and **iodides**) fail **trephining** is indicated. For ENCEPHALITIS, CEREBELLITIS, MENINGITIS, ARACHNITIS, and TUBERCULOUS MENINGITIS, see MENINGES AND BRAIN, DISEASES OF.

### FOREIGN BODIES IN THE BRAIN.

As the result of traumatism, bullets, knife-blades, arrowheads, umbrella ferrules, nails, wire, splinters of wood, pipe-stems, fragments of bone, clothing, hair, etc., have been found lodged within the cerebral substance. The symptoms caused by the presence of foreign bodies in the brain are treated of in PENETRATING WOUNDS OF THE SKULL AND BRAIN and GUNSHOT WOUNDS. The following course of treatment is advised: Gentle **probing** or the use of the **Röntgen rays** to detect the presence and location of the foreign body, no force being used. **Remove the fragments** about the

wound of entrance. The wounds in the scalp, skull and dura should preferably be **excised**. The entire track of the foreign body should be disinfected. Extraction is most easily effected under **fluoroscopy**. Where this is not available, an attempt to locate the missile should be made with some device such as Flührer's aluminum **probe** or Senn's probe, allowed to enter the track by gravity. A small, soft **catheter** is then passed down to the foreign body and used as a guide for **forceps**, with which the missile is extracted. When the foreign body is found to have passed through to the opposite side of the skull, a **counteropening** for its extraction as well as for drainage is generally advisable. **Drainage** is necessary in these cases. **Dichloramine-T** may be used for disinfection. An **antiseptic dressing** having been applied, the head should be placed in the best position for drainage.

Bleeding can be controlled by a **tampon** of **iodoform gauze**. After applying the antiseptic dressing apply **cold** to the **head**. Absolute **rest** and quiet are imperative. The **diet** should be light and nutritious, **stimulants** being added, if necessary.

### TUMORS OF THE BRAIN.

**SYMPTOMS.**—The symptoms of a cerebral tumor vary according to the size of the growth, its location, the rapidity of its development, the age of the patient, the character of the tumor, and the indirect effects on distant portions of the encephalon. These may be classed as general and focal. Usually the former are the first to attract the attention of the patient, but occasionally the manifestations of the latter are the first to

cause him to seek the advice of a physician. The general symptoms are usually headache, intermittent or constant, with periods of exacerbation, going on for weeks or months before dizziness, nausea, and apparently causeless vomiting are complained of; not infrequently disturbance in vision or a general convulsion occurs before or soon after the headache has become severe enough to interfere with the comfort of the patient. In the cases in which focal symptoms have been the first to appear, convulsive movements, limited to a group of muscles, to one limb, or to one side of the body, or symptoms of speech disturbance lead the patient to seek relief. As the disease advances the early symptoms become more marked, and numerous others are added, much to the discomfort and incapacity of the patient. Headache, if not severe before, soon becomes agonizing; vision gradually or rapidly lessens; vomiting often occurs with or without nausea, especially in early morning, when the lesion is situated in the posterior fossa or at the base of the brain, and the patient may become greatly emaciated; sustained mental effort is impossible, both on account of the headache which it usually augments and on account of the mental deterioration resulting from brain disturbance; walking may become difficult or impossible, either from paralysis or from interference with muscular co-ordination, the latter usually being due to a growth in the posterior cerebral fossa, the cerebellum, or in the region of the corpora quadrigemina; there may be disturbances of special and general sensory phenomena. Various respiratory and

circulatory irregularities may be present. Usually the patient becomes stuporous and finally comatose before death takes place. In a few cases convulsions cause death before the patient dies from exhaustion.

Among the general symptoms, headache, double optic neuritis (choked disc), vomiting, vertigo, and general convulsions are the most important.

**Headache** is often the earliest symptom, and is usually one of the most prominent, constant, and distressing. It is present in from 75 to 95 per cent. Eskridge's experience led him to believe that it is rarely absent throughout the course of the disease. It is less constant and less severe in certain gliomatous growths. It often intermits, and may be absent for prolonged periods, especially while the patient is taking large doses of potassium iodide, although the tumor may not be syphilitic in character. The headache is often agonizing, especially during the periods of its exacerbation. In some cases the pain is so great, especially in subtentorial tumors, as to cause death in a few weeks, or, at most, in a few months, from the time that the headache becomes prominent. It is usually worse at night. In many cases, while the pain is sufficient to interfere with sleep and mental exertion, it is much less intense than in the severer ones. In not a few the pain amounts to little more than an uncomfortable cephalic fullness or tightness, with an occasional exacerbation. The pain may be lancinating, rending, stabbing, dull, heavy, or boring in character. It is usually most severe when the tumor is rapidly growing, when situated at the base

below the tentorium so as to exert pressure on the veins of Galen, or in the cortex; least severe in slowly growing tumors, especially when situated in the centrum ovale. The pain may be increased by anything that augments the blood supply to the brain. It may be diffused or limited to one or more regions of the brain. Its location is no positive indication of the seat of the tumor, except in those cases in which the growth is superficial and involves the membranes, when the pain, and tenderness on percussion, may correspond to the seat of the morbid process. Tumors in the frontal region less frequently give rise to occipital pain than a growth in the posterior portion of the brain causes frontal headache. A persistent occipital or suboccipital pain usually points to a subtentorial growth, and, in these cases, pain often radiates down the posterior cervical region. A tumor in one cerebral hemisphere may give rise to pain in the opposite side of the head and nowhere else; but a unilateral occipital headache usually corresponds to the side of the head on which the growth is situated.

Headache in brain tumor becomes more intense when the patient suddenly changes his position or makes a rapid movement with his head; changes of position may first elicit the headache. Lack or subsidence of headache, however, is no evidence against brain tumor. Slow high-tension pulse and absence of the tendon reflexes are occasionally found as manifestations of high pressure in the brain. An acute onset with rising temperature and frequent fluctuation in the intensity of the clinical picture suggest rather hydrocephalus and serous meningitis than tumor, while a constantly progressive clinical picture speaks for a tumor, although the

latter may be accompanied by hydrocephalus with resulting fluctuation in the symptoms. Bychowski (*Deut. med. Woch.*, March 10, 1910).

**Choked Disc, Optic Neuritis, and Optic Nerve Atrophy.**—Choked disc, or optic neuritis, while not usually an early symptom, occurs in over 80 per cent. of the cases of tumor of the brain. It begins acutely, and only a few days or weeks may elapse from its first appearance until it has reached a degree of considerable intensity. An ophthalmoscopical examination may reveal it while vision is still well preserved. It is usually bilateral, but the morbid process is further advanced in one eye than in the other. When it is unilateral the indications are that the disease is anterior to the optic chiasm. Knies states that "simple neuritis, terminating in atrophy, is found less often than choked disc in cerebral tumors." According to this writer, it happens in tumors of the frontal lobe in which the tumor is close to the optic nerve. In all such cases the disc is choked to a greater or less extent, and when the stage of atrophy has set in the sinuosity of the vessels near the disc will be the only means by which to determine the secondary nature of the atrophied nerve. Primary atrophy of the optic nerve probably does not occur as a result of tumor of the brain.

Papilledema should be looked upon as a very late symptom of brain tumor. Even when of slight degree and without loss of vision, it demands relief as soon as possible. The case should come to the surgeon when fundal changes are still slight or not yet even observable. In lateral recess tumors, the papilledema may be quite sudden and progress rapidly, often with a greater edema on the side of the tumor. In general, tumors most

distant from the midline are the most likely to cause a papilledema equal on the 2 sides, while in tumors near the midline the edema is more advanced in 1 or the other eye. However, mesial growths from the falx, pineal, or interpeduncular space usually cause changes equally marked on the 2 sides.

Papilledema is likely to be late in anterior frontal tumors and in dural growths over the motor area. It is sometimes completely absent because of pressure of the growth on a large brain artery, causing extensive softening. C. A. Elsberg (*Arch. of Ophth.*, July, 1924).

Choked disc seems to occur less frequently in tumors of the medulla, and of the centrum ovale of the middle and anterior portions of the brain; most frequently when the growth is situated in the cerebellum, the corpus callosum, the corpora quadrigemina, and the great ganglia, or at the base of the brain.

**Vomiting**, a frequent symptom of tumor of the brain, occurs most commonly when the growth is large and rapidly growing, situated in the cerebellum near the middle lobe or in the neighborhood of the corpora quadrigemina. It is a prominent symptom in about one-half the cases, often associated with severe headache, and may be projectile in character, and not associated with taking food or with nausea. When the growth is so situated as to affect the middle lobe of the cerebellum or corpora quadrigemina, vomiting may be produced by any sudden movement of the patient's head. Vertigo in many cases is unassociated with vomiting, but it may be a very annoying symptom, and almost constant, yet unattended by vomiting. Like the latter, it is most frequent in tumors of the cere-

bellum and adjacent parts. A general convulsion may precede other symptoms or it may occur at any stage of the disease. It is found in about one-third of the cases, and denotes active progress of the disease. General convulsions rapidly following each other late in the disease may prove fatal. Mental disturbance, insomnia, somnolence, and syncope are found in many cases.

**Focal symptoms** may be direct and result from the invasion of a portion of the brain by the growth, or indirect and due to its interfering with the function of structures more or less distant from the tumor. Both sets of symptoms are frequently present and prominent at the same time, requiring great care to separate the one from the other.

Incomplete hemiplegia, monoplegia, limited convulsive movements (Jacksonian epilepsy), paralysis or spasm of single muscles or groups of muscles, and contraction are the local disturbances in motility that may result from tumor of the brain. There may be, also, various perversions of the sensory phenomena, hemianopsia, and aphasia, depending upon the seat of the growth.

The **course and duration** of intracranial growths are variable, depending upon the character of the tumor, its location, and the complications. The symptoms are usually gradual in their development, in a few rapid, and in others they are arrested for several months. Some tuberculous growths may apparently run their course in a few weeks on account of the presence of meningitis, while others extend over a period of years. In a few cases, after a growth has gradually progressed several months

or a year without any very alarming symptoms, death may suddenly occur with symptoms of a vascular lesion. The average duration of tumor of the brain is about fifteen months, but the variation is from a few months to two or three years, or even a greater length of time.

In the majority of cases of cerebral tumor there is a syndrome of endocranial hypertension which varies with the nature, localization, and development of the tumor. Evolution without signs of hypertension occurs mainly in cases of glioma, angioma, or hard sarcoma. Hypertension is early and intense in tumors of the posterior cranial fossa. Headache, amblyopia, vomiting and vertigo are the cardinal symptoms. The first 2 symptoms are the most constant. Headache is of little value, but amblyopia may be of diagnostic value. It is early and intense in the case of basal tumors and those of the posterior fossa; it may be absent or very slight in frontal and parietal tumors. Castex (*Rev. Assoc. med. argent.*, xxvii, 770, 1917).

**DIAGNOSIS.**—The first problem for the diagnostician to solve in a case is: Are the symptoms due to organic intracranial disease? When an organic lesion develops in a nervous subject, symptoms, functional in character, will be added to those of organic disease. Hysteria and organic disease are not infrequently found in the same subject at the same time. A multiplicity of symptoms pointing to hysteria is of less importance in enabling one to make a diagnosis than the presence of one symptom organic in origin. As a rule, symptoms that are usually regarded as organic when caused by functional disturbance are temporary and fleeting in character, and the opposite, while true in the vast majority of cases, finds a notable exception in

multiple sclerosis of the central nervous system. Marked muscular wasting in the distal portion of a paralyzed limb of cerebral origin, associated with flexor contracture and decided increase of the deep reflexes over those of the corresponding limb of the opposite side; most cases of crossed paralysis or pronounced trophic disturbance in one or both eyes, of cerebral origin; more than transient lateral homonymous hemianopsia or sensory aphasia, may be regarded, in the vast majority of cases, of organic origin, although only one of these conditions exists. There are other and more frequent symptoms which are always very strong evidence of organic brain disease, but not positive proof of it. Among these the first in importance is optic neuritis, or choked disc. The latter may be due to tumor, renal disease, lead encephalopathy, or pronounced anemia. The first condition named produces much more swelling of the disc than is found resulting from any of the last three; besides, in the latter, there are evidences of either renal disease, lead poisoning, or anemia. Intraventricular effusion or abscess of the brain may cause choked disc, but these diseases have their distinct symptoms. It must be borne in mind that organic brain disease may be present in a person suffering from disease of the kidneys, lead poisoning, or anemia. Under such circumstances a careful analysis of the symptoms and a study of the case will enable the physician to determine the nature of the case. Persistent headache, obstinate vomiting, and vertigo are frequent symptoms of intracranial growths, but they rarely continue long unassociated

with eye changes, except possibly in tumors of the medulla. Paralysis or spasm of the ocular muscles, rapid in its development, and facial paralysis, not extracranial in origin, are usually due to organic brain disease. In hemiplegia of organic origin the deep reflexes of the paralyzed side are greatly in excess of those on the non-affected side. This is not so in hysteria. Hemianesthesia, including the special senses, as observed by Gowers, "is one of the rarest effects of cerebral tumors, and is absolutely unknown from this cause unless associated with loss of motor power." Whether it occurs from tumor or other forms of organic brain disease, affecting the posterior portion of the internal capsule, the lateral hemianopsia, homonymous in character, will differ from the "crossed amblyopia" sometimes seen in hysteria. Persistent sensory aphasia is probably almost always due to an organic brain lesion. Convulsions, general or local, must be seen and carefully observed by an intelligent nurse before the true nature can be determined by the physician. It is well to bear in mind that a febrile condition simulating—by its periodicity—malaria may occur in the course of organic disease of the brain, especially in connection with abscess, tumor attended by rapid softening of the surrounding substance, tuberculosis, and possibly syphilis.

The commonest mistake in cerebral tumor is, perhaps, to diagnose hysteria. Formerly there was some excuse for this. But we know now that inverted color fields is a sign not of hysteria, but of increased intracranial tension, and that hysterical anesthesia is induced, evanescent, and easily removable. The hysterogenetic zones are merely the normal erethistic



areas which most easily provoke instinctive defense reactions, or may be the artefacts of suggestion. Contractures and palsies are now also clearly comprehended as direct or indirect results of suggestion.

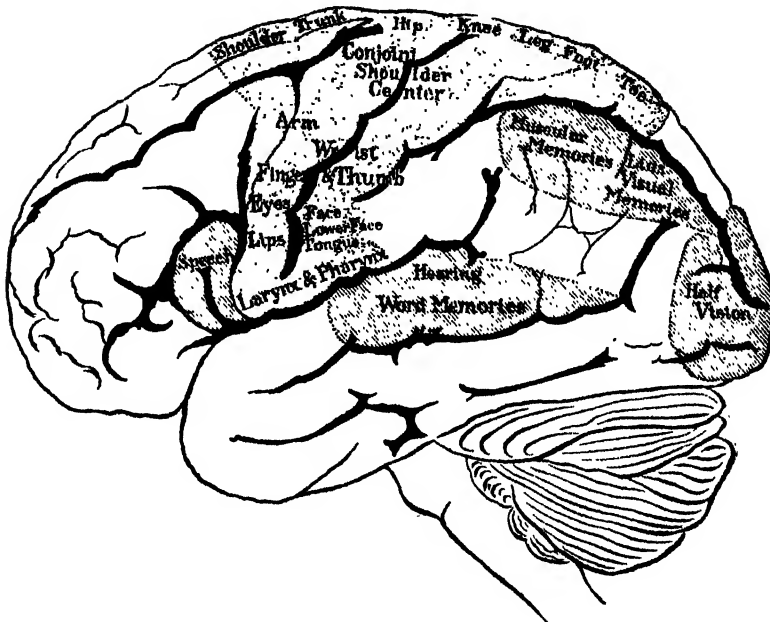
Again, the deep reflexes are not in reality modified hysterically, although here two qualifications must be mentioned: 1. By imitative suggestion, a reflex may appear to be modified, but it is not difficult as a rule to detect intentional interference of the patient. 2. Systemic states interfering with the nutrition of the neurons often modify reflex responses, sometimes unequally in different parts of the body. Such toxic states very often also increase the patient's suggestibility. T. A. Williams (*Archives of Diag.*, Oct., 1911).

Having satisfied ourselves that organic disease of the brain is present, the next question to determine is: Is it tumor? It is rare that tuberculous meningitis is likely to be mistaken for tumor, except possibly in those cases which run a prolonged course. These are often attended with tuberculous nodules or even a tuberculous growth of considerable size. Under such circumstances the symptoms will partake of the character of meningitis and intracranial tumor, those of the latter predominating when the growth is large, and those of the former when the deposits are small. In those cases in which a tumor has existed prior to the development of meningitis, not infrequently a history of attacks of apparently causeless vomiting, attended with severe headache, may be obtained. Aneurism is diagnosticated by detecting a bruit. The principal symptoms of chronic cerebritis are headache, vomiting, and distinct optic neuritis, without localizing symptoms. This condition probably can-

not be distinguished from tumor of the brain unattended by focal symptoms and pronounced choking of the discs. Chronic hydrocephalus with effusion into both lateral ventricles need not be mistaken for tumor if the symptoms of each are borne in mind and the history of the case is carefully studied. Distention of one lateral ventricle with pronounced unilateral choked disc was mistaken by me for tumor in a case in which the history was unobtainable. A syphilitic meningitis or a nodular tuberculous condition of the meninges attended with great thickening of the membranes to such an extent as to give rise to distinct focal symptoms is clinically indistinguishable from an intracranial tumor. Alcoholic meningitis usually affects the convexity, and tremor is present. One needs only to be familiar with the delusions of grandeur, the character of the mental failure, and other symptoms common to parietic dementia to prevent his confounding it with tumor of the brain. The same may be said of the other forms of insanity, especially mania. In multiple sclerosis the tremor is bilateral; in tumor with tremor the latter is usually unilateral. The atypical symptoms of hysteria and parietic dementia often found in diffuse sclerosis of the cerebrum will aid in preventing this disease from being mistaken for tumor. In diffuse sclerosis if the cerebellum is affected and there is staggering gait, with a tendency to fall to one side, the absence of severe headache, optic neuritis, and vomiting will be against tumor and in favor of diffuse sclerosis. Chronic abscess of the brain does not cause total blindness or marked choking of the optic discs.

Sudden onset of symptoms in brain tumor witnessed in a number of cases. In some, the abrupt illness proved to have been due to a hemorrhage into the tumor or neighboring tissues. Aside from hemorrhage, the rise of pressure may be due to alcohol or traumatism. Once the precarious intracranial balance in latent brain tumor has been broken, a fatal ending is not far distant. While the symptoms resemble those of a vascular

premotor region of the frontal lobes. The mental symptoms are the most constant, but these are variable. The patients may be apathetic, disregard the ordinary proprieties of life, and become filthy and partially demented as the disease progresses. Some exhibit a childishness foreign to their nature, and talk much of trivial things, especially when these relate



Brain, left hemisphere. (Dana.)

lesion, such a brain lesion is rare before 40 years in persons with an intact cardiovascular system. G. Wilson and N. W. Winkelman (*Atlantic Med. Jour.*, Feb., 1925).

What is the seat of the tumor? If the tumor is in the premotor region of the **frontal lobe**, there may be few positive focal symptoms. Headache is rarely so agonizing, vomiting so constant, or choked disc so frequent as in tumors in the posterior portion of the brain. Choked disc is absent in one-half the cases of tumor of the

to themselves; others are irritable, impatient, and at times may show a maniacal tendency; while nearly all manifest a lessened power of sustained attention and mental concentration, with absent-mindedness and lack of judgment. Amnesia is rarely complete unless the tumor is very large or both lobes are involved. If the tumor extends backward motor symptoms become manifest, and disturbances of speech are added in lesions of the left side in right-handed persons. Ataxia of the cerebellar

type has been observed by a few in tumors of the frontal lobe.

Report of 3 cases of frontal tumor. Vague mental symptoms were present in all. One case showed symptoms not unlike those of profound cerebral exhaustion or beginning paresis. Headache was never a marked feature, existing only for a short time before death; vomiting occurred but once, and there was no optic neuritis or involvement of the visual fields. The only suggestive symptom was one attack of slight twitching of the left leg, without loss of consciousness. Occasionally psychic vesical incontinence was present. In another case, with early headache, optic neuritis, and vomiting, there were typical areas of hysterical hyperesthesia under both breasts and over both groins, as well as hyperesthesia over the left parietal region. Left hemiparesis, present for a time only, may also have been hysterical in origin. F. X. Dercum (*Jour. Nerv. and Ment. Dis.*, Aug., 1910).

**Tumors in the Rolandic, or so-called motor, region** usually give rise to definite localizing symptoms. In the irritative stage of tumors of the cortex, there are Jacksonian epilepsy, involving the muscles of the face, arm, or leg, according to the seat of the growth, and sensory disturbance, often in the form of auræ and numb or tingling sensations, limited to the regions involved in the convulsive movements. After the lesion becomes destructive in character, weakness or paralysis of the affected muscles takes place. As a rule, after every Jacksonian convulsion, the muscles involved in this are weak or paralyzed for a short time. The muscles first affected in the convulsion are the last to cease jerking, are the weakest, and denote the seat of the irritation in the brain. It is important to study the initial phe-

nomena and the order in which one group of muscles after another is involved by the convulsion, as these afford aid in localizing the primary seat of the brain lesion, especially early in the history of the disease. In some cases, probably those in which the irritation is limited to the cortex, the seizure may, for a time, consist of pain, numbness, or tingling sensations, limited to the distal portion of an extremity, or these may immediately precede a convulsive movement, which always begins in the part in which the sensory disturbance is first felt. When the convulsion begins in, or decidedly affects, the muscles of the lower face on either side, but most pronounced when the right is involved, temporary motor aphasia often follows the attack. Some subjective sensory loss, in the distal portion of the limb, is common in tumors of the motor cortex. According to Dana, the sense of localization is most affected.

**Tumors of the parietal region** may or may not give rise to localizing symptoms, depending upon their size and the involvement of certain structures. It is thought by some that muscular sense is affected by a lesion in the supramarginal convolution. On the left side in right-handed persons, or on the right side in left-handed ones, a growth affecting the angular gyrus or inferior parietal lobule produces word-blindness. If the optic radiations are encroached upon by the tumor, lateral homonymous hemianopsia will be present.

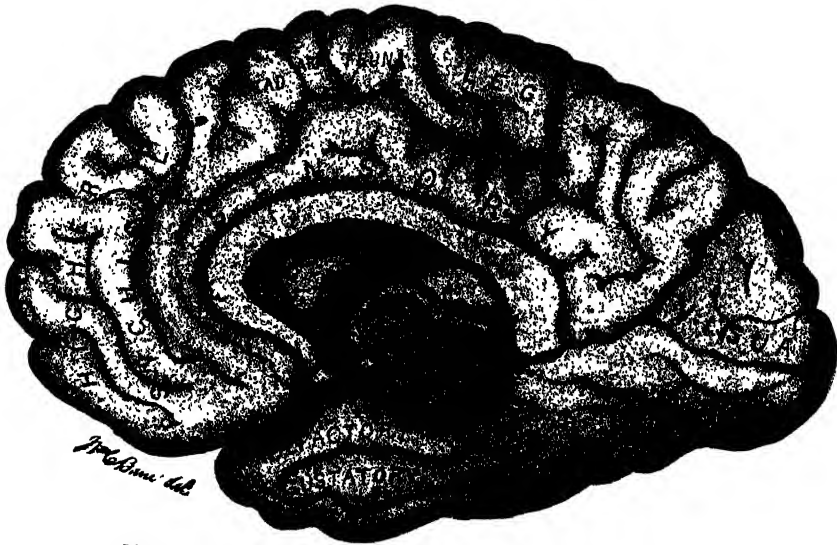
**Tumors of the occipital lobe** affecting the cuneus or optic radiations will cause lateral homonymous hemianopsia, the blind fields being on the side opposite to that of the lesion.

Mind-blindness has been observed in connection with growths in the left occipital lobe, especially near its anterior portion.

**Tumors of the temporosphenoidal lobe** may give rise to no focal symptoms, when they are situated on the right side. On the left side word-deafness will result if the posterior portions of the first and second convolutions are affected. When the an-

the corpora quadrigemina by the absence of oculomotor symptoms until late in the disease, and from growths in the cerebellum by the cranial nerves of the bulb escaping.

**Tumors of the great ganglia** give rise to no focal symptoms until the internal capsule is affected either directly or indirectly. Complete hemianesthesia from tumor in the basal ganglia practically does not occur



Median aspect of the right hemiserebrum, showing cortical centers.

terior portion of the lobe is involved near the base on either side, disturbances in smell and taste may be present.

**Tumors of the corpus callosum** may cause general symptoms of intracranial pressure, and, later, hemiparesis, or bilateral weakness, with rigidity of the muscles of the trunk and legs, and often ataxia of the cerebellar type. The disturbances are usually more marked on one side than on the other, and the legs are affected to a greater degree than the arms. Tumors of this region with ataxia are distinguished from those of

without motor defect. When the hemianesthesia is complete, all the special senses may be lessened or lost on the anesthetic side, the visual defect being lateral homonymous hemianopsia, with the blind fields on the side corresponding to the affected side of the body.

Athetoid movements and marked inco-ordination, chiefly affecting the hand, have been observed in lesions of the thalamus. A tremor which is similar in character to that of multiple sclerosis has occurred from tumor in this region, but it is always unilateral.

**Tumors of the corpora quadrigemina**, besides the general symptoms, such as headache, double choked disc, and vomiting, cause ataxia and incomplete ophthalmoplegia. The ataxia is similar to that observed in lesions of the middle lobe of the cerebellum. Bruns states that the ophthalmoplegia will precede the ataxia when the lesion is in the corpora quadrigemina, but the ataxia will precede the former when the tumor is in the cerebellum.

**Tumors of the crus** produce "crossed paralysis," hemiplegia on the opposite side of the body,—including the limbs and lower side of the face,—and paralysis of the third nerve on the side on which the tumor is located. Hemianesthesia will be present on the hemiplegic side if the fibers on the upper or posterior portion of the crus are involved. If the optic tract is seriously affected, lateral homonymous hemianopsia will be present, and the pupils will not react to light thrown into the eyes from the side of the blind fields (the hemiopic pupillary reflex of Wernicke).

**Tumors of the pons** give rise to distinct, but variable, symptoms, depending upon the size and exact location of the growth. A tumor may be situated to one side of the pons and cause decided pontile symptoms from direct pressure, and if the pons is pushed to one side, against the bony structure, as not infrequently happens, the indirect pressure symptoms on the opposite side of the pons from the seat of the tumor may be very pronounced. If the tumor is situated in the upper portion of the pons, on one side there will be "crossed paralysis," and possibly hemianesthesia, as

in tumor of the crus. During the irritative stage of the sixth nerve, the eyes may be spasmodically jerked toward the side of the lesion; but when this nerve is paralyzed, conjugate deviation of the eyes will be to the opposite side. The symptoms from a tumor in the upper portion of the pons on one side—if from diffusion of irritation the sensory tract on the opposite side is not affected—would be conjugate deviation of the eyes to the opposite side, weakness or paralysis, and disturbances of sensation throughout the entire opposite side of body, head, and face. Owing, however, to the diffuse character of the symptoms, both direct and indirect from tumor of the upper portion of the pons, the symptoms are more likely to be dilatation of the pupils, ptosis; strabismus, at times; sometimes cloudiness and ulceration of the cornea; pain, with hyperesthesia and anesthesia in the region of the distribution of the fifth nerve on side corresponding to that of the tumor, and hemiplegia and hemianesthesia of the opposite side of the body and face, the latter if the lesion extends deep in the substance of the pons, often in the form of dissociation of sensory symptoms (loss of pain and temperature sensations; tactile preserved) and loss of conjugate movement of the eyes toward the side of the lesion. Other cranial nerves would probably be affected as the disease progressed. A tumor situated in the lower half of the pons on one side would give rise to crossed motor and sensory paralysis; the face, both the lower and upper on the side of the lesion; the body and limbs, on the opposite side. Marked trophic disturbances usually occur through the

distribution of the affected fifth cranial nerve. Articulation, deglutition, and respiration become affected in lesions of the extreme lower portion of the pons from the involvement of other cranial nerves. As a rule, these are late symptoms in the course of the disease. Tumors lying between the pons and dura often cause bilateral symptoms on account of the cord being pushed against the bony structure. They differ from those caused by tumors within the pons in being more irritative and less destructive in character until late in the course of these growths, and cranial nerve symptoms precede those of the pons.

Glycosuria and albuminuria may occur, giddiness is often intense, and vomiting troublesome if the middle peduncle of the pons is involved. The tumor may directly affect both sides of the pons and produce bilateral symptoms. The knee-jerks are as frequently absent as present, and are extremely variable: present and exaggerated at one time, normal or absent at another.

Case of tumor in the left temporal lobe invading the thalamus and left crus, with symptoms suggesting pontile involvement. At the autopsy many small hemorrhages were found in the upper pons and the floor of the fourth ventricle. C. H. Frazier (*Prog. Med.*, Mar., 1926).

**Tumors of the cerebellopontile angle** generally arise from the acoustic nerve; they may, less frequently, be attached to the facial, abducens or trigeminal nerve. Cerebral nerve symptoms are always produced, but growth of the tumor is slow, and years may elapse before pressure palsy of the motor nerves just alluded to appear. Pressure on the lateral

lobe of the cerebellum and the pons induce corresponding symptoms, and there may also arise general pressure symptoms due to pressure on the iter. Involvement of the acoustic nerve results in tinnitus, deafness, objective vertigo, sudden falls, and at times sudden blindness, unconsciousness, forced movements and tonic extensor spasms. Involvement of the fifth nerve is marked by neuralgia and by anesthesia of the face and cornea on the same side; of the sixth nerve, by internal strabismus, and of the seventh, by unilateral facial palsy.

The Bárány tests (see under **INTERNAL EAR**, this Volume) are practically conclusive in the diagnosis of cerebellopontile tumor, as well as of some value in all tumors in the posterior fossa.

The Bárány test may be usefully applied to differentiate tumors of the frontal lobe, which fail to modify the vestibular or cochlear functions. Out of 11 cases of definitely established brain tumor comprised in a series of 100 cases of deafness, vertigo, vomiting or staggering, there were several in which, other evidence being inadequate, localization was assisted by use of the Bárány tests. Wishart (*Jour. of Laryng. and Otol.*, Mar., 1923).

**Tumors of the medulla** at first may give rise to unilateral symptoms, but these soon become bilateral, and are somewhat similar to those of progressive bulbar paralysis, except that sensory as well as motor fibers are affected in the former. It must not be forgotten that an intradural tumor of the medulla gives rise to bilateral symptoms on account of the displacement of the medulla to one side against the foramen magnum.

**Tumors of the cerebellum** cause well-marked general symptoms, such

as headache, double choked discs, vomiting, and often dizziness. Focal symptoms, however, will be entirely wanting if the tumor is not very large and situated in one hemisphere, especially in its posterior portion, so as not to affect the functions of the middle lobe or those of the pons. The most reliable and constant symptoms of a growth affecting the middle lobe are the disturbed muscular movements, the cranial nerve symptoms, and the subjective sensations of insecurity, both while standing and lying. The inco-ordination of muscular movements is most pronounced in the legs, next in the trunk, and least in the arms. The patient's gait is similar to that of a drunken person, the feet well separated laterally in standing and walking, and the body is often thrown to one side, forward, or backward by forced muscular movements. There is no paralysis of legs or arms, unless the fibers in the pyramidal tracts are affected, and no anesthesia. The patient has a sense of insecurity of his position, especially while standing, and this is sometimes complained of when he is lying in bed. If the tumor is situated well forward and in the median portion of the middle lobe, the cranial nerve symptoms will be bilateral; if to one side they will either be unilateral or, at least, most marked on the side corresponding to the tumor. The facial, auditory, and sixth nerves are most commonly affected. The ophthalmoplegic symptoms observed in tumors of the cerebellum affecting the superior peduncles appear secondary to the inco-ordination; when they are due to a tumor in the corpora quadrigemina they precede the ataxia.

*Adiadochokinesis*, emphasized by Babinski as an indication of cerebellar lesion, consists of a difficulty in repeating a movement with rapidity and uniformity. A convenient test for it is rapid pronation and supination of the forearm; on the affected side there is slowness and irregular range of the movements, showing up most plainly in graphic records. Similarly, the fingers, in flexion and extension, fall out of alignment or fail to move simultaneously. Articulation and phonation are disturbed usually only in extensive lesions involving the vermis (Holmes).

Headache, projectile vomiting and choked disc are cardinal manifestations of cerebellar tumor, and of these, the vomiting is commonly the earliest. At times, however, the earlier symptoms may be an ataxic, stumbling gait and general muscular weakness, especially in the lower limbs. Strabismus and nystagmus may occur early, with facial weakness on the same side as the lesion. Later, the patient tends to fall backward or to one side, and may even fall over when sitting. Sudden vertigo is not uncommon, and may go on to unconsciousness. Cerebellar seizures occur, with sudden, short, forced movements, irregular and tonic in character, as opposed to the clonic movements in cerebral irritation. There is often faulty co-ordination, especially in locomotion. Jerky movements of the hands are frequent, and cerebellar catalepsy may occur. There is almost invariably a disturbance of the labyrinthine reactions.

In tumor of the lateral lobe, one expects diminished or lost reflexes on the side of the tumor and a tendency to fall to that side. The nystagmus tends to be slower and of greater amplitude on looking toward the side with the lesion, finer and more rapid on looking away from it. If the tumor is in the vermis, there is greater loss of equilibrium, with a tendency to fall forward or back-

ward rather than to the side. P. K. Menzies (N. Y. Med. Jour., Oct. 3, 1923).

**Tumors of the base** strictly limited to the anterior fossa would affect the olfactory nerves, but by extending backward into the middle fossa they may cause unilateral loss of sight or some form of hemianopsia. Mental symptoms are usually present on account of pressure on the anterior lobes. A tumor in the middle fossa, if situated near the sphenoidal fissure, may paralyze all the motor nerves to one eye and compress the first division of the fifth, causing unilateral ophthalmoplegia, anesthesia, and pain in the region of distribution of this division of the trigeminal nerve, together with trophic changes in the eye. The Gasserian ganglion and all the divisions of the fifth nerve—as well as the second, third, fourth, and sixth nerves—are exposed to the invasion of tumors in the middle fossa. Tumors of the posterior fossa injure the cranial nerves, pons, and medulla, and give rise to many of the symptoms of tumor of the pons and medulla, with these differences: that tumors in this fossa affect the nerves before they do the pons or medulla; in paralysis of the sixth nerve from injury to its trunk the conjugate fibers of the internal rectus of the other eye are not affected, as in nuclear paralysis of this nerve, and the seventh and eighth nerves are usually involved by the same lesion, as they all lie near together at the base.

**X-ray Examination.**—Such conditions as calcified tumors or cysts, endostoses, convolutional markings and sellar changes may be detected by simple röntgenography. Gliomata are not infrequently calcified. According to D. D. Talley, Jr. (Va. Med. Mthly., Feb., 1923), the entire growth or

part of it may be actually visible as a shadow, and the local pressure atrophy or erosion of the cranial walls or floor may likewise be significant.

**Ventriculography.**—The risk attending this procedure precludes its use until other diagnostic methods have been exhausted. As noted by Adson, Ott and Crawford (Radiol., Feb., 1924), the ventriculogram aids in the diagnosis of tumors only when the lumen of the ventricle is encroached upon, and does not always localize small lesions of the frontal or temporal lobes, unless there is unilateral hydrocephalus. In small midline tumors above the tentorium, or in infratentorial tumors, it reveals nothing more than obstruction of the aqueduct of Sylvius or fourth ventricle. (See also *ante*, under SURGERY OF THE LATERAL VENTRICLES).

**Ventricular Estimation.**—This method, described by Dandy (Surg., Gyn. and Obst., May, 1923), is intended to avoid the serious risks attending air injection in advanced intracranial hypertension with actual or impending coma. It consists in determining the position of the lateral ventricles by simple puncture; their size by measuring their fluid content, and the patency of the communicating foramina of Monro by injection of a dye to be recovered from the opposite ventricle. Displacement of both posterior horns to one side suggests a growth in the posterior  $\frac{1}{2}$  of the hemisphere. A small ventricle on one side is evidence against a tumor in the posterior fossa. A bilateral symmetrical hydrocephalus suggests a growth in the posterior fossa.

**MULTIPLE TUMORS.**—According to Dana, about one-seventh of all brain tumors are multiple. The tuberculous, cancerous, and melanotic varieties are most commonly multiple. Syphilis or tuberculosis in a patient with tumor of the brain points to the probable nature of the growth. Inherited syphilis very rarely gives rise to tumor of the brain. The most common cerebral growths in children are the tuberculous, and these may occur in child-



hood without the signs of tuberculosis in other portions of the body. The cerebellum, comparatively speaking, is remarkably exempt from syphilitic tumors, but the tuberculous and the gliomatous are the most frequent here. Growths in the cortex are usually syphilitic, tuberculous, or sarcomatous. Gliomata and sarcomata frequently occur in the centrum ovale, and may subsequently involve the cortex. The symptoms of most growths of the brain are at first favorably modified by active anti-syphilitic treatment. If the improvement is very great and can be maintained by such treatment, it is strong evidence in favor of the syphilitic nature of the growth.

#### **ETIOLOGY.—Predisposing**

**Causes.**—Cerebral growths may occur at any time of life. The third decade furnishes the largest number, about 20 per cent.; the first and fourth about 18.5 per cent. each, and the second and fifth about 14 per cent. each. They are rare in extreme old age. Steffen has reported a case of tumor of the brain in an infant four weeks old.

The character of the tumor varies considerably with the different periods of life. Tuberculous, cystic, gliomatous, and sarcomatous varieties are frequent in childhood and early adult life, the tuberculous largely predominating in childhood. Syphilitic growths are most common in young and middle-aged adults. The gliomatous, sarcomatous, and gliosarcomatous are most frequent during the latter period. In my experience I have found cystic growths much more frequent in adults than in childhood, although this is contrary to the results obtained from a

study of tabular statistics. Carcinomatous growths are found most commonly during the degenerative period of life.

*Sex.*—After the age of 50 tumor of the brain is found with about equal frequency in the two sexes, but before this time, not excluding early childhood, the male sex suffers nearly twice as often as the female. It seems, then, that the explanation for the increased liability of the male sex to suffer from tumor of the brain must be sought in conditions pertaining to the developmental and active periods of sexual life.

*Heredity.*—It is still doubtful whether hereditary influences, excluding the tuberculous and the carcinomatous, play any part in the causation of tumors of the brain.

It is probable that worry, anxiety, excessive alcoholic indulgence, cerebral congestion, and depressed states of the nervous system favor the development of cerebral growths in tuberculous and syphilitic subjects, and they favor the formation of cancerous growths in other portions of the body and secondarily in the brain in certain persons, especially those who are the offspring of families in which the history of cancer is found.

**Exciting Causes.**—There is apparently a direct relation between injury of the brain and the development of tumor in only a few instances. It appears from the study of numerous cases that this relation is frequently overestimated.

Reviewing the literature on tumors of the brain, by far the greater number of tumors were found in the frontoparietal lobes, constituting about 40 per cent., while about 9 per cent. were found in the pons. Nearly 50 per cent. of all tumors found were

gliomata, while only 8 per cent. were sarcomata. Some forms of glioma, however, are indistinguishable from sarcoma, while others show evidence of sarcomatous infiltration, thus forming a combination of the two.

In no case was there any evidence of hereditary tendency, but in a large percentage there was history of an injury to the head previous to the manifestations of the first symptoms. Lesions of the pons are especially diverse in their symptomatology, owing to the complex relations of this structure. The most characteristic symptom of lesions in it is crossed paralysis. The author reports 2 cases showing a marked difference in the clinical manifestations, though the post-mortem sections revealed a nearly total destruction of the entire pons in both instances. W. H. Bodenshtab (*Journal-Lancet*, Sept. 15, 1913).

Syphilis and tuberculosis are two of the most potent causes of tumors of the brain. I have no doubt that the time will come when we shall be able to attribute the origin of many tumors of the brain to micro-organisms.

Knowledge of the functions of the regions of the infundibulum and third ventricle is still very scant. A case which came to autopsy, showing a tumor limited to the lower part of the third ventricle and the infundibulum led the writers to conclude that clinical findings in man show that lesions of the third ventricle region may be accompanied by sensory disturbances, deep disturbances of the circulation and of the mechanism of hydration in the tissues. Claude and l'Hermitte (*Presse méd.*, p. 417, 1917).

**PATHOLOGY.**—According to Gowers, about four-fifths of the non-syphilitic tumors of the brain are either tuberculous or sarcomatous (including the gliomatous). It is difficult to determine the frequency of syphilitic tumors of the brain, as

so many cases yield temporarily or permanently to antisyphilitic treatment, and are lost sight of by the observer. The difficulty is still further enhanced from the fact that many cases of non-syphilitic tumors temporarily yield to antisyphilitic treatment, and may pass from under the physician's observations before their true nature is determined. The gliomata are found only in the central nervous system and in the retina, and occur far more frequently in the brain than in the cord.

From a study of Starr's tables, consisting of an analysis of 300 cases of tumor of the brain in children, in nearly one-half the tumor was found in the cerebellum, pons, and medulla, while in the same number in the adult only a little more than one-fifth were located in this portion of the brain and its stem. The cerebellum in childhood appears to be a little more than twice as often the seat of tumor as in adult life, but in adults the cortex of the cerebrum is the seat of tumors six times as often as in childhood. From a study of the location of tumors it will be found that portions of the brain inaccessible to the surgeon's knife are much more commonly the seat of growths in children than in adults.

Case of a child of 9, with mild skull injury six years earlier, in which attacks of headache, vomiting, and vertigo and choked discs appeared after the age of 4. In a recent attack consciousness was retained and there was only slight hemiparesis. A loud systolic murmur was heard over the skull, most pronounced over the right ear. The arteries to the brain were dilated, especially on the right side, and there was a mass of dilated veins at the outer border of the right orbit. The diagnosis was facilitated by a

radiogram, which revealed the circulatory anomalies. Improvement occurred after ligation of the right common carotid. The case was one of cerebral plexiform angioma. Isenschmid (*Munch. med. Woch.*, Jan. 30, Feb. 6 and 13, 1912).

Tuberculous growths are the most frequent of brain tumors, especially in childhood, and their most common seat is in the cerebellum or other structures in the posterior cerebral fossa. In nearly one-half the cases the growths are multiple, and give rise to a confusion of symptoms, especially in relation to localization. Syphilitic growths, which are often accompanied by endarteritis or a low form of meningitis, affect the cerebellum much more frequently than the cerebellum, and are found on the surface, either at the base or on the convex surfaces of the frontal lobe and the convolutions near the fissure of Rolando. Gliomata and sarcomata are frequent forms of tumor of the brain. The former grow from the neuroglial tissue, infiltrate the surrounding portions of the brain, may be of considerable size, and are often scarcely distinguishable from the adjacent brain substance; the latter develop from the connective tissue of the membranes and vessels, and are frequently capsulated.

Endothelioma should be borne in mind in cases with increasing cerebral symptoms, such as epileptiform attacks, while the eye-grounds and intellect remain clear. Headache and vomiting are slight or absent, and the general condition good. These tumors spring from the endothelium of the dura and gradually displace brain substance without destroying it, excepting very superficially in certain cases. They are not malignant, and have no tendency to local recurrence or metastasis, though not

encapsulated. G. L. Walton and J. Homans (*Boston Med. and Surg. Jour.*, June 27, 1912).

Case of tumor in a man of 60 which had destroyed nearly all the white matter of the right hemisphere from the frontal pole to the occipital pole. The sense of smell was lost but not vision. The absence of epilepsy indicated a subcortical site. The ataxia had not been accompanied by vomiting or other cerebellar symptoms. Xavier (*Annaes Paulistas de Med. e Cir.*, Aug., 1917).

Brain tumors are frequent in Argentina. The subjects are usually adolescents or adults under 40. The laboratory tests for syphilis, etc., are so unreliable with a brain tumor that the writer now pays little heed to them, basing the diagnosis on the clinical examination and the history of the case. Castex (*Revista de la Asoc. Med. Argentina*, Dec., 1917).

**PROGNOSIS.**—The tuberculous in children and the gummatous growths in young adults give the most favorable prognosis. In rare instances a sarcomatous growth may become capsulated and cease to grow or even decrease in size. The duration of life in tumors of the brain varies from a few months to two or three years. In exceptional cases life is prolonged for many years.

Because of great improvement in the technique of brain surgery there are few cases of brain tumor that one would hesitate to operate. One must distinguish two groups. (1) Sharply circumscribed tumors, sarcoma, endothelioma, fibroma, angioma, cholesteatoma, dermoid tumors of the pia, solitary tubercles, gummatous growths, and, finally, cysticerci and echinococci, and (2) infiltrating tumors—glioma and carcinoma metastasis. For a favorable outcome in the first group, the location is all-important, whether extra- or intra-cerebral. The prognosis in tubercle, gumma, and cysticerci is unfavorable.

because of the multiplicity of lesions. The prognosis in the second group is still worse, because in an infiltrating growth the border is difficult of recognition. Endothelioma, sarcoma, and neurofibroma offer the best opportunity for surgical success, and next comes cysticerci and echinococci, which are diagnosed early. When the tumor is situated in the brain stem, corpora mammillaria, pons, medulla, and third ventricle, operation is contraindicated. In all other cases it is to be recommended, though the percentage of complete recoveries is only between 3 and 4 per cent. Harvey Cushing (*Neurol. Centralbl.*, Oct. 16, 1913).

**TREATMENT.**—Persons suffering from tuberculous or syphilitic growths should be kept as well nourished as possible, by means of a generous and nutritious **diet**, and general **tonics**, consisting of **codliver oil**, **iron**, **quinine**, extract of **sumbul**, and **arsenic**, together with plenty of **fresh air**.

Where the Wassermann reaction is positive, and brain syphilis cannot be excluded as the source of the cerebral symptoms, the patient should receive **arsphenamin** intravenously, **mercury** by injection or inunction, and **potassium iodide** in doses rapidly increased from small to heroic. If the treatment is acting favorably, improvement in the papilledema will soon occur, and if the benefit in this and other respects is lasting, operative intervention becomes unnecessary. In this connection it should be borne in mind that in glioma anti-syphilitic treatment may cause temporary improvement. If the treatment is not beneficial within 6 weeks, it should be abandoned, and the advisability of **operation** considered. Indeed, in the late stages of brain tumor vigorous antisymphilitic treat-

ment for more than a week or two is not warranted if unsuccessful, as the risk of blindness from further operative delay is often great. Incidentally, a non-vascular gumma may not yield to specific treatment until pressure is relieved by operation.

Headache is lessened by keeping the bowels open freely each day, the digestive organs in the best possible condition, and avoiding causes that are likely to increase the blood supply to the brain. **Cold** to the **head** and a **mustard plaster** to the **nape** of the **neck** often relieve an annoying headache. Sometimes local abstraction of blood from the head by means of **leeches** to the temple or nape of the neck has been employed with benefit.

An anodyne, as **cannabis**, together with one of the coal-tar products, with or without **codeine**, should be employed before hypodermic injections of **morphine** are resorted to. **Mustard** to the **neck** and **over** the **stomach**, with **cold** to the **head**, will often relieve vomiting. Twenty to 30 grains (1.3 to 2 Gm.) of **hydrated chloral** given by the bowel in starch-water will often stop the vomiting as well as the general convulsions. **Morphine** hypodermically administered may be resorted to with confidence in the intractable cases of vomiting and general convulsions.

While complete **removal** of brain tumors is as yet successful only in a small minority of cases, the benefit from partial or palliative surgical procedures is such as to render intervention advisable in most cases. Inability to determine the site of the growth, or its inaccessible situation, frequently precludes radical excision, but even a partial excision is likely

to be very helpful. Where such procedures are not feasible, Cushing's **decompression operation** is a valuable palliative. This consists of trephining in the temporal region—on the right side in right-handed patients,—opening the dura to allow the brain to bulge in this area, and, while leaving the dura unsutured, stitching the dense temporal fascia and skin to prevent fungus of the brain. In cerebellar tumor, a suboccipital decompression may be carried out. The operation relieves headache and papilledema and reduces the risk of sudden death from respiratory failure or cardiac inhibition.

Although Tooth's post-operative mortality was 32 per cent., von Eiselsberg's 38 per cent., and Kuttner's 45 per cent., Cushing has reduced it to 8.4 per cent. The commonest neoplasm is the *endothelioma*, which is usually easily removed. It does not tend to recur unless the bone has been involved. *Glioma*, if encapsulated or degenerated, is removable, otherwise decompression alone will probably relieve the symptoms, prolong life, and give comfort as long as a more radical procedure. Cases of *fibrous tumors*, when successfully removed, being benign, are sure of recovery. They are the common tumors of the cerebellopontine angle. *Sarcoma* is certain to recur if the brain tissue is invaded. *Cysts* may be removed or the wall partially removed and drainage established. Baker (*Albany Med. Annals*, xxxvi, 230, 1915).

In cases in which the tumor is not found, if the patient is allowed to wait for some time after decompression a second operation will reveal the tumor, easily accessible. Shock can be largely avoided if the operator will work slowly and gently and employ large decompressions and exposures. *Hemorrhage* can be almost entirely controlled by the proper use of

**Horsley's bone wax** and **wooden pegs** for bone hemorrhage and **Cushing's cotton compresses** and the **Haidenhein hemostatic suture** for other bleeding. Strachauer (*Jour. Amer. Med. Assoc.*, Sept. 14, 1918).

Of 16 cases of glioma, 8 were treated by **decompression** at 1 or more sittings. In 1 case the man had had epileptic seizures for 3½ years, with progressive hemiplegia toward the last. A flap was cut in the skull and this relieved the tension and restored earning capacity. A year later symptoms returned, and the flap was found lifted up by gliomatous tissue. A decompressive operation permitted a survival of nearly a year. L. Bériel (*Lyon méd.*, Dec. 25, 1920).

Case of large epithelioma of the parietal lobe illustrating the fact that after removal of a brain tumor loss of balance between the formation and absorption of cerebrospinal fluid may continue for a considerable period. In the writer's patient **lumbar puncture** was required on this account for 9 months after the operation. Schloffer (*Med. Klin.*, Jan. 8, 1923).

Among 95 cases of cavity-forming gliomas, the average survival of 78 cases was 32 months, though 32 per cent. survived for 3 years, 23 per cent. for 5 years, and 6.7 per cent. for 10 years or more following **evacuation** of the cyst and treatment of its walls. P. Martin (*Arch. franco-belges de chir.*, Sept., 1923).

There are unaccountable differences in the behavior of *gliomas*, some of which may be enucleated without recurrence, while others are susceptible to **radiation**, others undergo complete cystic degeneration, and others still seem to grow more rapidly if disturbed in any way. In the case of the *meningiomas*, recurrence is always possible unless the growth is removed intact and along with it the entire dural area to which it has become attached. In *tuberculoma*, even after an apparently complete enucleation, tuberculous meningitis or recurrence seems to be inevitable. In *metastatic tumors* in the brain, operation is generally

futile. H. Cushing (Arch. of Neurol. and Psych., Dec., 1923).

Other palliative procedures include **dehydration** and **callosal puncture**. The former is carried out by administering hypertonic solutions, usually intravenously, *e.g.*, a 5 per cent. or stronger solution of **sodium chloride** or a 25 per cent. solution of **dextrose**. (See also *ante*, under INTRACRANIAL HYPERTENSION.) Instead, 3 ounces (90 Gm.) of **magnesium sulphate** in 6 ounces (180 c.c.) of water may be given by rectum every 4 hours, or 1 ounce (30 Gm.) of the same salt by mouth every 4 hours. During the study of a case repeated **lumbar punctures** may be useful, but they are not free from danger, especially in subtentorial tumors.

In 6 cases of inoperable brain tumor given 20 c.c. of 30 per cent. **sodium chloride** solution intravenously, relief for 10 hours to 2 days was afforded; repetition every 3d day usually kept the patients free of headache. The pressures were reduced in 20 minutes from 780, 940 and 840 mm. of water to 90, 100 and 70 mm. Sodium chloride by mouth in the dosage of 3 to 6 5-grain (0.3 Gm.) keratin-coated tablets 3 times a day gave much less pronounced relief. In a case of large cerebral hernia following operation for cerebello-pontine angle tumor, intravenous injection of hypertonic salt solution reduced the hernia, improved the gait, and relieved headache. H. Cohen (Brit. Med. Jour., Mar. 8, 1924).

**Callosal puncture** is employed not infrequently by the writer, who deems it preferable in many instances to subtemporal decompression, avoiding the unsightly hernia which develops when there is an obstructive hydrocephalus. The period of patency of the puncture varies, but there is always the possibility of repeating the operation alternately on the 2 sides. It is performed under local anesthesia. C. H. Frazier (Prog. Med., Mar., 1925).

Some interesting results have also been obtained with **X-ray** treatment, to which gliomas, in particular, are somewhat amenable.

Thirty-two cases of brain tumor treated by the **X-rays**. Of these 18 were still living, 1 to 7 years after the first treatment. In tumors presumably completely removed by the surgeon, **implantation** is contraindicated unless a large cavity persists and the **radium** can be packed in its center; otherwise the treatment should be by **crossfire** radiation, for which radium is to be preferred. If the tumor has been only partly removed, or not at all, the radium can be implanted, as nearly as possible in its center. Implantation should be supplemented by external crossfire radiation. H. K. Pancoast (Amer. Jour. of Roentg., Jan., 1922).

Of 242 patients treated with the **X-ray**, 59 received 6 or more treatments. Such treatment offers little hope of amelioration in meningioma, acoustic neuroma, or tumors of Rathke's pouch. *Pituitary adenomas* respond well to it, but it is not altogether without danger, and the visual fields should be carefully watched. At 3-week intervals the rays are directed to the pituitary fossa through 3 portals, *viz.*, areas  $3\frac{1}{2}$  inches square over the temporal bones and frontal region. A maximum skin dose is given at each sitting. *Gliomas* are sometimes very much improved; good results may thus be obtained in apparently hopeless cases. In deep or midline growths, crossfire from both sides is generally employed. In cerebellar cases this procedure is likewise often of value. The treatment should wait upon as accurate a localizing and pathologic diagnosis as it is possible to make, even if operation be necessary to establish it. Percival Bailey (Amer. Jour. of Roentgenol., Jan., 1925).

## HYDROCEPHALUS.

**DEFINITION.**—Hydrocephalus means an accumulation of serous fluid within the cranial cavity. The condition is frequently spoken of as

dropsy of the brain, or as "water on the brain," and may occur as an acute or chronic affection. The location of the fluid varies, but is more frequently found within the cerebral ventricles than outside the brain or between its membranes.

**VARIETIES.**—The term "internal hydrocephalus" is applied expressly to chronic hydrocephalus usually congenital in origin, and when the word *hydrocephalus* is used without qualification it is this variety of the disease which is universally meant. Hydrocephalus may be *primary*, or *secondary* to some other disease.

Acute hydrocephalus is nearly always secondary to basilar meningitis, while chronic hydrocephalus is more frequently primary, and very often congenital; it also often develops after birth without any apparent antecedent cause. Hydrocephalus has also frequently been classified as congenital and acquired; but since many of the cases, apparently beginning after birth, really owe their origin to the same obscure causes which determine the congenital cases, it would seem better to regard the condition as *acute* or *chronic*, and as *primary* or *secondary*.

### I. ACUTE HYDROCEPHALUS.

**—DEFINITION.**—Acute hydrocephalus means an effusion into the ventricles or within the membranes of the brain, as the result of an inflammation of the pia mater usually, either simple or tuberculous, or it may result from other intracranial or systemic organic disease.

**SYMPTOMS.**—The symptoms of acute hydrocephalus necessarily depend for their mode of development on the cause producing the effusion, and, as meningitis of some grade is

the most frequent cause, the signs of this disease very often precede and accompany those dependent upon the intracranial effusion. In other cases arising from gradual mechanical obstructions to the return venous circulation, the onset of symptoms indicative of ventricular dropsy may be most difficult to determine; so that, especially if other serious illness—such as summer diarrhea of infancy or one of the specific fevers—complicates the case, the diagnosis may be conjectural or even impossible. In such cases the meningeal affection sometimes runs a subacute course and gradually subsides, leaving an effusion which may, in rare cases, be reabsorbed, but which more usually tends either to remain stationary or to slowly increase in amount until the characteristic physiognomy of the hydrocephalic head is developed, and more or less permanent injury to the brain results, although such patients may survive for years in fair health.

Commonly, however, the signs of acute hydrocephalus appear during the course of one or other of the conditions to be referred to under etiology. When the primary disease is acute non-tuberculous basal meningitis, the child stricken with this disease is apt to be fretful, irritable, restless, and sleepless for from a few days to a week or two. Headache is another early symptom, and is usually combined with intolerance of a bright light, while the face is flushed and the anterior fontanelle pulsates strongly. At this early period there may also be strabismus of irregular degree. Vomiting is frequently an early symptom, and may be an extremely marked one. The tempera-

ture is that of moderate fever, but in severe cases there may be hyperpyrexia during the first two or three days or even longer. The pulse is in some cases distinctly slow and rather full, but in others much accelerated in rate and small in volume, or these conditions of the pulse may vary or alternate. The respiration is often shallow and irregular, and, after actual ventricular effusion has occurred in sufficient amount to cause compression of the brain, Cheyne-Stokes respiration is frequently noted, especially in the later stages of the disease. According to the severity of the cause producing the effusion coma develops slowly or suddenly, with twitchings and rigidity of limb, or of all the limbs. This tremor and stiffness of the muscles may include the neck and spinal muscles, and twitching movements of the facial muscles or of the head are very common. In the rapidly fatal cases the coma deepens and the pulse and respiration progressively fail. The face is void of expression; the eyes present marked contraction of the pupils, with occasional irregular movements of the ocular muscles; convulsions may occur and be repeated many times, and the little patient dies from failure of the respiration and of the heart's action.

In some of these severe cases, inflammatory in nature, there is often a marked remission of all symptoms, including the regaining of consciousness, a lessening of the spastic condition of the muscles, and a decided improvement of the general condition. This change for the better is too often a deceptive one, and is followed by a return of the same grave symptoms noted above preceding

death. In cases of simple non-tuberculous basilar meningitis the improvement may be real and the patient slowly recover, and after some months the recovery may be a perfect one. It is more common, however, that some permanent mental or physical defect is left as the result of the effusion, and such patients are a long time in recovering from the very marked emaciation which always is present and in some cases is extreme.

The course of the disease may be extremely variable, and the duration from a few days to many months. In such cases the characteristic hydrocephalic head may develop, and the case very much resemble one of chronic hydrocephalus. This variability in this disease we must assume to be directly dependent upon the grade and extent of the primary inflammation, which in certain cases runs a subacute or almost chronic course, which may finally end in more or less perfect recovery. Even in the most favorable case, when effusion has taken place into the ventricles, it is extremely rare that this effusion wholly disappears. The clinical and post-mortem evidence is strongly in favor of the view that when effusion once occurs it is, at best, only permanently limited in the favorable cases, the brain gradually accustoming itself to the changed conditions, while the majority of the cases show a tendency toward progressive increase of the ventricular accumulation.

When tuberculous meningitis is the primary condition, the same prodromal symptoms are usually noticed as have been above noted as ushering in non-tuberculous meningitis. At times the onset is very acute, but



it is more apt to be gradual, with slowly rising temperature, which does not commonly run so high as the temperature curve of typhoid fever, nor does it often exhibit the very marked remittency usually observed in that disease. Irregularity of the pulse, some changes in the respiration rhythm, retraction of the abdomen, irregularly contracted pupils, slow and irregular lateral movements of the eyeballs and unilateral or bilateral flushing of the face, the *tache méningique*, gradually develop. A violent convulsion, followed by hemiplegia with involvement of the face, may be the next symptom, and it may or may not be preceded by twitchings of the facial and orbital muscles. In many cases amaurosis, ptosis, strabismus, or facial paralysis alone may be noticed after a convulsion. Drowsiness may be present from the beginning of the illness, but coma comes on early or late, according to the severity of the case, and the clinical picture is one of coma slowly ending in death.

Examination of 182 cases of meningitis, 94 of which were tuberculous, showed hydrocephalus present in a little over 40 per cent., while in 88 cases of non-tuberculous meningitis it was present in 50 cases, or 56 per cent. The author alludes to angioneurotic edema as a cause of internal and external hydrocephalus. Guthrie (Pract., July, 1910).

The lateral cerebral ventricles, when filled with air, can be clearly seen under the fluoroscope. By fluoroscopy **hydrocephalus** can be diagnosed accurately at all stages of its development. Several unsuspected cases of hydrocephalus have been demonstrated by the fluoroscope. The diagnosis of a false ventricular hernia (ventriculocoele) was made with certainty, because the air from the ven-

tricle could be seen to pass directly into the swelling. Dandy (Bull. Johns Hopkins Hosp., Feb., 1919).

The symptoms attending the course of other conditions producing acute hydrocephalus, and non-inflammatory in nature, naturally depend upon the nature of the obstruction to the venous circulation and the manner of its occurrence. In cases arising from enlargement of the bronchial glands the cerebral effusion may accumulate very slowly and be unsuspected until the case is far advanced, when prominence of the fontanelles, with absence of pulsation, some increase in the size of the cranium, coupled with gradually oncoming stupor, tremors, convulsive seizures, or some form of paralysis, may direct attention to the cerebral condition. The clinical course of these cases, which are fortunately of rare occurrence, is extremely variable, and the same may be said of the symptoms presented before actual dropsy of the ventricles occurs, and evidences of intracerebral pressure become manifest, so that such forms of the disease, while they may develop acutely, approach very closely and often run into chronic hydrocephalus. In all cases of acute hydrocephalus the changes in the shape and size of the skull may be very slight, and if the disease occurs after the ossification of the cranial bones such changes cannot be detected by measurements.

**ETIOLOGY.**—Any cause which operates by obstructing the venous circulation within the cranial cavity may cause an acute effusion of serum into the ventricles or elsewhere within the skull. Thus, intracranial tumors, enlarged bronchial glands, retropharyngeal abscess, and intracranial

hemorrhage are all causes of more or less acute hydrocephalus.

The same is true of certain diseases which cause, at times, enlargement of the bronchial glands, and thus, by pressure on the venæ innominatæ, obstruct the venous circulation of the brain, resulting in passive congestion and effusion of serum from the engorged blood-vessels. Acute hydrocephalus has also been frequently noted in connection with exhausting diseases, like severe cases of scarlet fever, typhoid fever, and prolonged diarrhea of children, especially that occurring in summer.

In the latter class of cases the effusion is partly the result of the actual wasting of the brain, which favors passive congestion of the organ, and is also due, in part, to the great weakness of the circulation, which is a special feature of protracted cases of infantile summer diarrhea. Syphilitic meningitis may also be accompanied by an acute effusion into the ventricles, and in all of these cases a careful study of the family history, and a very critical examination of the patient, should be made so as to discover, if possible, other evidences of the existence of syphilis.

Finally, certain writers have reported cases of so-called essential dropsy of the brain in which there could be found no anatomical lesion to explain the effusion. No case of acute effusion within the cranium should, however, be put into the last category, unless a careful and complete post-mortem fails utterly to reveal a pathological lesion, and the diagnosis of acute essential dropsy during life is certainly a wholly impossible one. Practically, acute intracranial effusion of serum is more

frequently seen as the result of tuberculous or simple leptomeningitis than from the other conditions above enumerated. (Acute hydrocephalus and tuberculous meningitis are often used as synonymous terms, but, in view of the many other conditions which occasionally give rise to the former, it would be well to discontinue such use of these terms as misleading to students.)

Occasionally intracerebral hemorrhage may result in the formation of a cystic accumulation of serum within the membranes of the brain or between them and the skull itself. Pachymeningitis may also cause a localized collection of serum. In such cases of localized cystic collections there is very apt to be marked pressure thereby of the subjacent convolutions. The amount of fluid present in any case of acute hydrocephalus is very small in comparison with the very large amount usually present in chronic hydrocephalus, and very rarely exceeds 4 or 5 ounces. When acute hydrocephalus arises from inflammatory disease of the membranes of the brain, the meningitis is commonly basilar. This is particularly true of the simple and tuberculous meningitis of children, while cases occurring in adult life frequently involve the membranes over the convexity of the brain as well. Leptomeningitis as a cause of acute ventricular effusion is most frequent before the end of the sixth year, and more often arises in subjects debilitated by previous disease, or by poor hygienic and social conditions.

Report of a case of acute internal hydrocephalus secondary to streptococcal infection of the labyrinth. An

operation on the labyrinth would probably have saved the patient's life had the true state of affairs been realized in time. S. R. Scott (*Arch. of Otol.*, April, 1908).

An internal hydrocephalus can be experimentally produced by occluding the aqueduct of Sylvius. Experiments made by the introduction of phenolsulphonephthalein into the lateral ventricles showed that the absorption of cerebrospinal fluid from the ventricles takes place almost entirely in the subarachnoid space. It passes directly into the blood, and the lymph-vessels are not concerned in its absorption.

When injected into the ventricles phenolsulphonephthalein normally appears in the urine in from ten to twelve minutes, and after two hours from 12 to 20 per cent. is excreted. After this injection into the subarachnoid space, it appears in the urine in from six to eight minutes, and from 35 to 60 per cent. is excreted in two hours. When injected into the ventricles, it appears in the lumbar spinal fluid within two or three minutes. In hydrocephalus this enables one to determine accurately the patency or obstruction of the channels of exit from the ventricles to the subarachnoid space. Fluid passes upward into the ventricles after injection of the chemical into the lumbar subarachnoid space.

With phenolsulphonephthalein two types of hydrocephalus may be readily differentiated by determining the patency or occlusion of the channels of exit from the ventricles. In the first type these channels are obstructed and hydrocephalus results because there is no absorption from the ventricles. In the second type the channels are patent and the hydrocephalus is due to diminished absorption from the subarachnoid space. W. E. Dandy and K. D. Blackfan (*Jour. Amer. Med. Assoc.*, Dec. 20, 1913).

The writers report 8 cases, all showing either complete occlusion of the aqueductus cerebri or obliteration

of the fourth ventricle by marked changes in the ependymal or subependymal tissue. Schlapp and Gere (*Amer. Jour. Pediat.*, June, 1917).

The writer found it advisable to divide the hydrocephalus of poliomyelitis into the following forms: 1. That of the onset (including the pre-paralytic and early paralytic stages). 2. That persistent after the first week of the disease and comprising three varieties: (a) a mild form commonly encountered in which there is only a slight increase in fluid and in which symptoms are practically absent; (b) a more severe form comprising various degrees, in which there are distinct signs of pressure; (c) a very severe type, more or less insidious in onset, indefinite in physical signs, and associated with evidences of progressive emaciation. Regan (*Amer. Jour. Dis. of Children*, Apr., 1918).

**PATHOLOGY.**—Post-mortem examination of the brain in acute hydrocephalus of inflammatory origin reveals usually a basilar leptomeningitis, which may be simple, tuberculous, infective, or syphilitic in origin, with an excess of fluid in the ventricles, causing a marked dilatation of them, while the substance of the hemispheres presents appearances due largely to the increased intracranial pressure. This intracranial tension often partly expels the blood from the vessels, especially during the last hours of life; so that at the post-mortem the brain substance may look anemic, especially over the vertex and throughout the substance of the hemispheres. In cases of simple leptomeningitis the naked eye appearances of the pia at the base of the brain will rarely present marked evidences of the intense hyperemia existing during life. The ventricles are distended with a slightly opaque or turbid serum, while the choroid

plexus is overdilated with blood, which may also be extravasated in punctiform patches in their immediate vicinity. The microscope shows extravasation of leucocytes along the lines of the blood-vessels and distending the perivascular sheaths, and also reveals minute capillary hemorrhages, pus cells, and in some cases compound granule cells, depending largely upon the duration of the disease. The cerebral substance in some cases may contain areas of softening, but the rule is to find no such lesions, and, with the exception of changes in shape from pressure, the convolutions may be normal.

When tuberculosis is present it is usually also at the base in children, but may involve large areas of the pia mater in older subjects, and in adults the vertex is not infrequently the site of the tuberculous deposit. The characteristic post-mortem appearance is the tubercle, and the location in which this is most commonly found is in the pia overlying the crura cerebri, the optic, olfactory, and the point of exit of the third nerve, and also in the membrane as it extends over the corpora quadrigemina. The pia is much thickened, is covered by a grayish-white exudate, and the tubercles show as whitish-gray bodies imbedded in the membrane. In size the tubercles vary from exceedingly minute bodies, hardly discernible macroscopically, to that of the head of a pin or even somewhat larger. The ventricles are distended with a turbid albuminous fluid, and there is thickening and softening of the ependyma. The microscope confirms the diagnosis and reveals the existence of numerous obstructions of the smaller arte-

rioles from tuberculous deposit, or an obliterating endarteritis. Giant cells may be seen in the perivascular spaces or in the cerebral substance, while the *Bacillus tuberculosis* is seen along the lines of the vessels and in and around the areas of the tuberculous deposits. In all cases the bronchial glands should also be examined, since they are frequently a most important factor in the production of the ventricular effusion.

**DIAGNOSIS.**—The diagnosis of acute hydrocephalus is not difficult when it occurs as the result of meningitis. In such cases the prolonged coma, the irregular movements of the muscular system, with the respiratory rhythm, are all suggestions of the increased intracranial tension due to the ventricular effusion. The subacute cases are, perhaps, the most difficult of recognition, and the condition of the brain may remain unsuspected until the graver symptoms appear. The cases arising rather abruptly from the pressure of intracranial growths or from enlarged bronchial glands also present many difficulties in the way of early diagnosis, but the appearance of grave signs of cerebral disturbance, the discovery in certain cases of other evidences of tuberculosis, or of retropharyngeal abscess causing embarrassment to the cerebral circulation, the exclusion of traumatism, the ophthalmoscopic examination, and a careful study of the history of the illness will often aid in making up an opinion. The very fatal cases which occur in large cities, especially during the course of the diarrheal diseases of infants and young children, present few difficulties in their recognition, because the brain symptoms

develop so early and progress so rapidly toward death. In these cases the tendency toward a marked, but most deceptive, remission of symptoms should be borne in mind. In all cases of acute hydrocephalus the general wasting of the body is a prominent feature. In cases of long duration the emaciation may become extreme, and contractions occur in the limbs which may be more or less permanent should recovery take place. The characteristic hydrocephalic aspect is rarely seen in acute hydrocephalus, unless the case should drift into the chronic condition, cases of which are only rarely seen. Cases arising from meningeal hemorrhage usually become chronic, the fluid being encysted between the membranes of the brain.

**PROGNOSIS.**—The prognosis of acute hydrocephalus is always bad. The disease ends usually in death, or in permanent mental or physical defects in the cases which escape death. Probably the syphilitic form is the most hopeful when the condition is suspected early enough to get the patient promptly under the influence of specific remedies. The cases arising from enterocolitis, or any of the acute fevers or other exhausting disease, offer little hope as to recovery, although occasionally a patient will recover. The tuberculous cases are absolutely hopeless, although Jacobi and others have testified to the recovery of two or three cases. Sub-acute basilar meningitis may cause ventricular effusion and subside, leaving the effusion, which may remain stationary in amount or even lessen in bulk so that the symptoms of its presence disappear; but usually the tendency is for it to increase, and

finally, after months or years, the clinical picture of chronic hydrocephalus is produced, should the patient have been a young child, thus admitting of the expansion of the cranium.

**TREATMENT.**—The treatment of acute hydrocephalus is very often that of the primary disease to which the ventricular effusion is only secondary. Sometimes, from the very rapid progress of the case toward a fatal end, treatment can be of little avail. In the majority of cases it is almost hopeless, but in all cases every effort should be made, for occasionally the recovery of one of these cases from a seemingly hopeless condition will amply repay the untiring care which they all demand.

When the initial symptoms of meningeal irritation appear, should the patient be seen at that early period, absolute **rest** in a darkened room, prompt **vesication behind the ears with cantharidal collodion**, in children, and regular doses of **calomel** in great amount should be instituted. If necessary, **opium** should be given to control the restlessness, preferably combined with **chloral**, and these should be continued in suitable doses so long as the twitchings and spastic muscular condition continue. **Irrigation of the bowels** should be practised where there is enterocolitis as the cause.

In all cases every part and organ of the body should be very carefully examined so as to exclude complicating conditions and establish the diagnosis. The initial treatment is of the greatest importance, for after the effusion has occurred there is less hope of doing good.

When the patient is a sthenic sub-

ject and the arterial tension high, **leeches** or **wet cups** to the **mastoid regions** may be employed. After these measures the **spinal ice-bag** should be used in the cases with high temperature; and they should be avoided in those with low temperature range, as collapse has been induced in such patients in my own experience. The **bromides** and **chloral** will usually be demanded to mitigate the tendency toward convulsions, while they both tend to lessen cerebral hyperemia. **Chloral** may be used as a **rectal injection** in cases where the stomach is non-retentive. In some cases the **warm bath** is desirable and helps to calm the muscular system.

The **diet** should be carefully regulated and stimulants should not be given unless demanded by the condition of the pulse. In the later stages signs of collapse should be watched for, and that condition anticipated, when possible, by the prompt administration of a rapidly acting stimulant, such as **ammonia**. Should the patient recover from the acute stage of the disease, **diuretics**, including the **acetate** and **iodide of potassium**, should be employed, with **tonics**, **massage**, and **electricity**, in order to increase the nutrition proportion and activity of the muscles. Although the percentage of recoveries is exceedingly small, it is large enough to warrant the utmost zeal in the treatment of these distressing cases.

In cases of epidemic cerebrospinal meningitis in which threatening hydrocephalus is detected in the second or third week of the disease, a single **lumbar puncture** is sufficient sometimes not only to relieve the symptoms, but to arrest the progress of the disease at a critical moment by

removal of the excess of toxins or bacteria from the interior of the cranial cavity. Koplik (*Amer. Jour. Med. Sci.*, April, 1907).

**Puncture of brain** recommended in acquired hydrocephalus. The best technique is to puncture the scalp, bore a small hole in the skull with a fine, blunt, smooth drill, and introduce a fine, hollow needle attached to a hypodermic syringe. Acute or subacute hydrocephalus in adults is frequently diagnosed as migraine, and a rapidly fatal termination may be averted by prompt puncture, as also in cases of a superficial local intracranial collection of fluid. Pollack (*Deut. med. Woch.*, May 19, 1910).

**Direct puncture of the ventricles** may be of service in cases of acute intraventricular effusion, and occasionally when internal hydrocephalus is progressive and bids fair to become chronic. Lumbar puncture, however, should always be tried first, even when the symptoms of pressure are associated with otitis media.

From its occasional success, **drainage of the subarachnoid space** by passing a trocar and cannula into the subcerebellar cistern, introducing a horsehair drain, sewing up the dura, and cutting off the drain close to its outer surface, is worthy of trial when, owing to obstruction, lumbar puncture fails to relieve.

Occasionally **mercurial inunction** seems to produce good results in syphilitic infants who show signs of incipient hydrocephalus. But the author does not think congenital syphilis a common cause of hydrocephalus. In early stages **leeching** the occiput is not an irrational procedure. The author has known recovery just once to take place in well-marked posthasic meningitis after powerful counterirritation with **tartar emetic ointment**. Such methods are useless unless applied early. L. G. Guthrie (*Pract.*, July, 1910).

**Ventricle drainage by puncture of the corpus callosum** in acute obstructive hydrocephalus due to cerebrospinal meningitis is recommended by

the writers. Case in which, on callosal puncture, about 25 c.c. of very slightly turbid, blood-stained fluid was obtained, whereas four hours previously, 40 c.c. of cloudy fluid had been withdrawn by lumbar puncture. Ventricular block was proved by the way in which the fluid gushed from the cannula. The immediate improvement was almost miraculous. Stetten and Roberts (Jour. Amer. Med. Assoc., Jan. 25, 1919).

Hydrocephalus developed in a young man 4 years after a contusion of the chest. Frontal headache and impaired vision of sudden onset, with normal spinal fluid, called for a **decompression** operation, which was followed by gradual improvement. Fracassi (Rev. Med. del Rosario, Apr., 1923).

**II. CHRONIC HYDROCEPHALUS.—DEFINITION.**—Chronic hydrocephalus means a progressive accumulation of serum within the ventricles of the brain, or in rare cases external to the brain and between its membranes, or between them and the skull itself; or in all of these situations. It is characterized by enlargement of the head, an almost pathognomonic facies, and by a progressive tendency toward death; often from gradual failure of the vital powers, or from intercurrent disease, or rarely from rupture of the head.

**VARIETIES.**—The term *internal* hydrocephalus is used to denote the cases in which the effusion is ventricular, while *external* hydrocephalus is used to denote the cases in which the effusion is external to the brain. The former class of cases is by far the more numerous, and is meant when the word hydrocephalus is used alone. The disease may also be *primary* or *secondary*. Many of the cases are congenital, but in the majority of instances it is first noticed some weeks after birth.

**SYMPTOMS.**—The symptoms of chronic internal hydrocephalus and the external variety of the same disease are similar and differ only in degree. External hydrocephalus is extremely rare, and is secondary, in the vast majority of the cases reported, to meningeal hemorrhage and to pachymeningitis. It is also found in cerebral atrophy, probably as a compensating lesion, and also has been found in cases of congenital cerebral malformations. The amount of fluid found is very small in comparison with that found in internal hydrocephalus, but some cases have been reported in which the head was decidedly enlarged and the sutures separated.

Internal hydrocephalus, which is the ordinary variety met with in practice, presents as its chief symptom an enlargement of the head. In some cases this enlargement is very great, as in a case reported by Steiner which exhibited a cranium  $32\frac{3}{4}$  inches in circumference at the eighth month. The normal circumference of the head at one year is given by Holt as from 18 to 19 inches. The increase in size of the head is usually in all directions, and the sutures in marked cases are widely separated, while the cranial bones are expanded and thinned out until sometimes they have a parchment-like sensation to the touch. The fontanelles are very large and bulging; the veins of the scalp are engorged; fluctuation of the head is quite common, and it may also be translucent to light. The scalp is stretched and thin and exhibits very little hair.

On the other hand, internal hydrocephalus may exist with no perceptible enlargement of the head and

with perfect, and even premature, ossification of the cranial bones. Primary cases of internal hydrocephalus are most often congenital, but in most cases the condition is only recognized after some weeks subsequent to birth; but in other cases the condition develops rapidly *in utero*, and puncture of the head may be necessary to effect delivery. In the largest class of cases nothing is noticed until several weeks have elapsed after birth, when the abnormal size of the cranium attracts attention. The child is also noticed to have difficulty to support or move the head, or is incapable of supporting it at all. Soon drowsiness and apathy are apparent in the infant, and it sinks into a condition of hebetude with all the senses less acute than normal. There is apt, at this time, to be either undue flaccidity or stiffness of the extremities. The latter condition is more common and the thumbs are adducted with the fingers tightly closed. The pupils are usually contracted, but at times irregular or dilated. There is marked general emaciation. Convulsions may occur and be repeated, and slow rolling of the eyeballs laterally or more or less strabismus may be features of the case.

The rapidity of the enlargement differs very much in different cases, and the clinical history depends largely upon this fact. In cases in which the increase of fluid is very slow the brain seems to accommodate itself to the pressure, and the symptoms of intracerebral pressure may be very few or almost entirely lacking until the case is far advanced. When chronic hydrocephalus is secondary, and arises after ossification

of the cranial bones is firmly established, the symptoms of increased cerebral tension are earlier and more markedly seen, although the amount of fluid in the ventricles is relatively very small in comparison to the primary cases. A well-developed case of internal hydrocephalus presents quite a striking and characteristic appearance. The face is small and overshadowed by the enlarged cranium; the forehead is prominent and bulging; the eyes are directed down and formed so that the white of the eye is always more or less uncovered by the upper lids; the child is often restless, and there is frequently twitching of the extremities; a short, sharp cry is often given, and, taken in connection with the emaciated body, the picture presented is almost pathognomonic of the disease. The head is often rather flat behind, with bulging sides and greatly rounded frontal regions.

**ETIOLOGY.**—Chronic hydrocephalus arises often, especially the congenital cases, without any demonstrable lesion of the brain. In many cases it is due to meningitis, or to other organic disease of the brain, such as tumor. Some authorities attribute a large proportion of the cases to syphilis, which certainly does appear often in the family histories.

Other authors ascribe the congenital defect to rickets, but this connection is not by any means clearly proved, for much confusion has arisen from the fact that, clinically, rickets and hydrocephalus have frequently been confounded, but they are sometimes associated. Primary hydrocephalus has also been causatively referred to tuberculosis, but there is lack of positive evidence. The influence of heredity is probably an im-



portant factor; often two or more children in the same family have been affected.

Extreme overwork and worry in the mother seem to constitute a factor in determining the occurrence of primary hydrocephalus. Uterine disease or injury during pregnancy may induce hydrocephalus by causing circulatory disturbances in the embryonic brain. In some cases of secondary hydrocephalus the cause can be clearly traced to an antecedent mild attack of basilar meningitis, or to a basal tumor, or to some mechanical cause producing venous stasis in the vessels supplying the ventricles.

The main source of the cerebrospinal fluid is the choroid plexuses of the ventricles, while the main area of its reabsorption is the venous sinuses bounding the subarachnoid space. Accumulation of the fluid may result either from excessive secretion, as may occur in cardiovascular or kidney disease or chronic inflammation, or from an impediment to absorption, such as occurs through obstruction at some point in the ventricular channels, particularly the foramina of Magendie, Luschka or Monro, the aqueduct of Sylvius or at the points of outflow into the sinuses. If but one foramen of Monro is closed, unilateral hydrocephalus may arise. Most cases of congenital hydrocephalus are ascribed to an inflammation of the ventricular lining, involving the choroid plexuses and attended with obstruction of venous return and consequent hypersecretion of fluid.

A tumor in the vicinity of the ventricular channels may cause hydrocephalus by directly obstructing them, while a more remote tumor may lead to the same result by forcing the pons

and a portion of the cerebellum down into the foramen magnum, thus interrupting the current of cerebrospinal fluid into the spinal spaces.

**PATHOLOGY.**—The lesions found *post mortem* are caused by the enormous dilatation of the ventricular cavities in which the effusion usually accumulates. Thus, in very marked cases all the walls of the ventricles are extremely thin, the septum lucidum is obliterated, and in extreme cases nearly all of the brain substance may have disappeared.

The fluid found in chronic hydrocephalus is slightly alkaline, translucent, specific gravity about 1005, and contains a trace of albumin and sometimes sugar. It also contains traces of alkaline chlorides and phosphates. The fluid in cases arising from meningitis is usually more turbid and contains a larger percentage of albumin. The quantity varies from a few ounces, in secondary cases, to 6 pints or more in primary cases.

The brain substance is anemic; often there is no line of demarcation between the gray and white matter. Severe cases show, under the microscope, marked degeneration of the nerve elements. The ependyma is often found thickened, infiltrated with leucocytes, and granular to the naked eye. In some cases it has undergone degenerative changes. Probably ependymal lesions are often directly responsible for the effusion itself, and have resulted from an antecedent attack of ependymitis, simple or specific, and often occurring in fetal life.

The bones of the cranium are more or less widely separated, sometimes to the extent of 3 inches. More rarely premature ossification has occurred, and in these cases the head is

not enlarged. The cranial bones are remarkably thinned, and may be almost as thin as paper. Spina bifida is quite frequently associated with hydrocephalus, and, less frequently, some form of meningocele or encephalocele complicates the case.

**PROGNOSIS.**—Complete recovery is practically unknown. In the most favorable cases the enlargement of the head spontaneously ceases after some years, and the patient may live for many years, but with no diminution in the size of the cranium. Mental defects are common in such cases. The majority of cases progress more or less rapidly to a fatal end. The rapid cases die within the first year, and it is very uncommon for a case of marked infantile hydrocephalus to live over the sixth year of life. Death usually results from marasmus, intercurrent disease, or from convulsions ending in coma from which the patient cannot be roused. Very rarely rupture of the head is a cause of death.

**DIAGNOSIS.**—The diagnosis is usually an easy one. Chronic hydrocephalus must be distinguished from rickets and hypertrophy of the brain. No error is liable to occur in the very marked cases, but when the effusion is of moderate amount the diagnosis may demand careful examination. From hypertrophy of the brain hydrocephalus is separated by its more rapid development, the greater enlargement of the head, the fluctuation which is often present, the universal character of the expansion of the cranium, which is more marked at the vertex in hypertrophy of the brain, and by the almost pathognomonic facies of hydrocephalus, including the oblique direction of the

eyes, with failure of the upper lid to completely cover the eyeball. To the touch hydrocephalus is softer and more compressible than hypertrophy.

From rickets chronic hydrocephalus is distinguished by the rounded head, which in rickets is square or angular and often marked by nodules; also by palpation and the other signs of the hydrocephalic head above noted. In rickets, also, there will usually be other evidences of the disease in other parts of the body.

Cases of chronic external hydrocephalus may present more difficulties in diagnosis, but they are of very rare occurrence, and careful examination will usually separate them from the cases under consideration.

**TREATMENT.**—The treatment of chronic hydrocephalus by internal remedies only rarely results in any benefit. Probably the best diuretic and alterative in these cases is the **iodide of potassium**, which should be given a trial in cases where it is not especially contraindicated.

Surgically, **compression of the skull** by adhesive plaster applied in strips has been tried, and cases of marked improvement have been reported as resulting from this treatment. The treatment much in vogue is a combination of **pressure** by means of **adhesive strips** covering in the entire vault and sides of the cranium, with occasional **aspiration** of moderate amounts of fluid, followed by the reapplication of the adhesive plaster. The effects of the pressure must be carefully watched and the strips loosened or removed should dangerous symptoms appear. If syphilis is suspected **mercurial inunctions** to the head should be practised.

Other modes of treatment are: in-

cision with drainage, puncture by the trocar, blisters, lumbar puncture, and cisternal drainage. Callosal puncture followed by closure of the scalp wound (**ventriculostomy**) gives temporary relief; the mortality from the procedure has been put down as 2 per cent.

Krause found a light silver tube introduced into the ventricle useful for continuous drainage, and Dandy has placed a drain in the Sylvian aqueduct.

Four types of hydrocephalus are recognized by the writer: (1) *Hydrocephalus obstructivus*. This, the old "internal" variety, is due to blocking of 1 of the outlets for cerebrospinal fluid through a congenital defect or owing to inflammation. (2) *Hydrocephalus non-absorptus*. Absorption of fluid is defective as proved by the phenolsulphonaphthalein test. (3) *Hydrocephalus hypersecretivus*. Probably due to disease of the choroid plexus. (4) *Hydrocephalus occultus*. Occurs usually in children, is characterized by excess of fluid, without enlargement of the skull, and symptomatically resembles a brain tumor. Such a case was operated and relieved.

In determining the variety, phenolsulphonaphthalein is injected into the lumbar subarachnoid space, and the urine tested. Next day the drug is injected into the lateral ventricle, and its excretion into the spinal canal tested by lumbar puncture. With these tests one localizes an obstruction if there is one.

In the obstructive type, puncture of the **corpus callosum** is advocated; in the non-absorptive type, drainage into the pleural cavity. In a case due to hypersecretion, **thyroid feeding** proved very successful. C. H. Frazier (Am. Jour. Dis. of Child., Feb., 1916).

In operating for hydrocephalus, the writer inserts 6 linen strands into the ventricles in the internal type, and merely into the subarachnoid and subdural spaces in the external type

of hydrocephalus, and brings their ends through the temporal muscle and fascia beneath the scalp in a stellate manner. Of 41 cases, 13 could not survive the sudden loss of cerebrospinal fluid. Later this difficulty was overcome by elevating the head. In the other 28, results were very encouraging, all but 6 showing progressive improvement. Sharpe (Amer. Jour. Med. Sci., Apr., 1917).

**Theobromine sodiosalicylate** (diuretin) recommended in the communicating type, but not where complete obstruction exists. It acts by increasing surface tension. The author gave 0.2 Gm. (3 grains) 3 times a day during a prolonged period. Circumference of the head decreased in several cases and increased when the drug was stopped. It also favors recovery when there is a tendency to spontaneous cure. Marriott (Amer. Jour. Dis. of Childr., Oct., 1924).

**Anastomosis between ureter and spinal dura** for drainage successfully employed in an infant with progressive hydrocephalus and convulsions. The child developed apparently normally in the 5 subsequent months. The upper funnel-shaped portion of the ureter was included, reaching the spine without traction. Heile (Zent. f. Chir., Oct. 3, 1925).

Every effort should be used to increase nutrition by **codliver oil, tonics, massage, and careful feeding.**

ERNEST LAPLACE

AND

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**HEART AND PERICARDIUM, DISEASES OF THE.** (See also **ENDOCARDIUM AND VALVES, DISEASES OF**, Vol. IV; **ANGINA PECTORIS**, Vol. I, and the sections that follow the present one.)

**IRREGULARITY OF THE HEART BEAT.**

Irregularities of the heart beat are of such frequency and so readily

recognized by both patient and physician that it is necessary to differentiate clearly the various types and to determine their meaning and significance. Formerly the general term "irregular pulse" could have meant much or little; but at the present time, owing to the constantly increasing employment of instruments of precision, the more serious irregularities are differentiated from those of a less serious nature and, in consequence, patients are not subjected unnecessarily to elaborate methods of treatment, nor are the burdens of unwarranted restrictions imposed.

The normal excitation wave for cardiac contraction arises in the *sinoauricular node* or the "pacemaker" of the heart, as it is commonly called. It lies at the junction of the superior vena cava with the right auricle. The pacemaker is composed of neuromuscular tissue, is approximately  $\frac{1}{2}$  inch long and is under the influence of the sympathetic and pneumogastric nerves. The right vagus nerve exerts its influence principally on the rate of the heart, while the left vagus nerve influences more the rhythm of the heart, although neither one is concerned solely with one phase of heart control. From the pacemaker the excitation impulse spreads out over the auricles in concentric rings, causing auricular contraction. The wave arrives at the junctional tissue between the right auricle and ventricle and is conducted to the ventricles by the intra-ventricular conducting mechanism called the *bundle of His*, which divides into a right and left branch to the right and left ventricles, so that both chambers contract at the same instant of time.

Cardiac irregularities are caused

by some delay in the origin of the excitation impulse at the pacemaker, or else by some interference in its propagation through the heart. The pacemaker is the most excitable portion of the heart, hence the normal rhythm starts there; but any part of the heart muscle may become more excitable than the pacemaker and an abnormal rhythm result.

Cardiac irregularities are classified as follows:—(1) Those arising in the sinoauricular node, called *sinus irregularities*. (2) *Premature systoles* (sometimes called "extrasystoles"). (3) *Auricular fibrillation*. (4) *Auricular flutter*. (5) *Heart block*. (6) *Pulsus alternans*.

**SINUS IRREGULARITY.**—The heart's contraction, arising normally in the sinoauricular node, is set to a regular rhythm. This node may be excited or depressed by nerve influence and an irregularity result. This type of irregularity is known as *sinus arrhythmia* and frequently occurs in the youthful heart. It is characterized by a varying length of the cardiac cycle, the pulse beats being equal in volume. It occurs so frequently in persons who show no other signs of heart abnormality that it cannot be regarded as anything more than an exaggeration of the normal phenomena.

It is important to recognize sinus arrhythmia in order that it may not be confused with other types of irregularities of a more serious nature. The irregularity bears a definite relation to respiration; the rate increasing on inspiration, decreasing on expiration and remaining unchanged when the breath is held. Sinus arrhythmia is without pathologic significance and requires no

special treatment. The very presence of sinus arrhythmia may safely be regarded as evidence that the heart is not diseased.

Description of an "intermittent" type of sinus arrhythmia in which periods of acceleration of the pulse alternated with periods of normal pulse. The orthodiagraph showed that the heart was exceptionally small, while the clinical findings indicated hypothyroidism. The use of **thyroid gland** improved the disorder. J. de Meyer (Arch. des mal. du cœur, Mar., 1922).

**PREMATURE SYSTOLES.**—Premature systoles may be of auricular, ventricular or nodal origin. Their source can be definitely ascertained by instruments of precision. Patients may be aware of the irregularity and describe their sensations as "the heart turning over," "the heart standing still," etc., and often seek relief from these alarming sensations. The irregularity occurs in hearts otherwise unaffected and can be appreciated clinically at the wrist by a premature beat followed by a long pause; or, only the long pause may be felt. Premature systoles may occur with greater frequency, *e.g.*, every second beat (*pulsus bigeminus*), or a few may follow each other in rapid succession (*multiple premature systoles*). The irregularity may be present for years in hearts that show no other evidence of heart involvement.

Among the frequent causes of premature systoles are focal infections at the apices of teeth, infective tonsils, gall-bladder infections, gastrointestinal disturbances, and even the toxins of fatigue.

In 100 cases seen in office practice, the age ranged from 11 to 66 years. The symptoms varied from those of heart failure in 9 cases to none in 35

cases. The main complaints were of shortness of breath synchronous with the extrasystole and sensations of grabbing, tearing, grasping, palpitation, turning of the heart, a lump, jerking, emptiness, shaking or fullness. Coffee, tea, cocoa or tobacco seemed responsible in 21 cases, alcohol in 3, digitalis in 3, strychnine in 2 and aspirin in 1. Seven pregnant women had extrasystoles which disappeared after confinement. Extracardiac infections and toxemias seemed responsible in 31. In 14, no cause could be found. The extrasystole arose in the ventricle in 87, in the bundle in 8, and in the auricle in 5. The polygraph or electrocardiograph is necessary for such differentiation, which many consider of prognostic value. Of the 96 patients still living, normal rhythm returned on treatment in 56, though 7 of these develop extrasystoles on taking coffee or tobacco. From his study the writer cannot believe that the myocardium is impaired in any manner by extrasystoles. A. L. Smith (Ann. of Clin. Med., Nov., 1924).

Auricular premature systoles are of less significance than those of ventricular origin. Those of right ventricular origin are of less significance than those originating in the left ventricle. Premature systoles usually disappear following exercise; if they persist or increase following exercise, this may be an indication of heart muscle involvement.

From a study of their significance based on 13,231 cases the writer concludes that premature contractions are an expression of myocardial hyperirritability. Whether of intrinsic or extrinsic origin they are important because they often produce a sudden increase of intravascular strain. Auricular premature contractions are practically always intrinsic in origin and usually indicate definite damage to the auricular myocardium. They often precede flutter and fibrillation and give rise to paroxysmal tachycardia. Right ventricular premature contrac-

tions are often extrinsic in origin and due to pressure, but they may be intrinsic, when they usually indicate right heart strain or exhaustion. Left ventricular extrasystoles often indicate left ventricular fatigue and precede failure, especially in aortics. Premature contractions of any type in complete heart block seriously disorganize and embarrass the circulation and must always be regarded as serious. J. S. Goodall (N. Y. Med. Jour., Feb. 15, 1922).

Auricular extrasystoles are usually symptomless, while the ventricular are of the type of which the patient is conscious. J. H. Musser, Jr., and T. McMillan (Penna. Med. Jour., Oct., 1922).

**Treatment.**—The treatment is directed toward the removal of the cause, and the prognosis usually is good. There is no specific treatment; however, **bromides** or **hypnotics** may be of temporary use in allaying the apprehensiveness associated with them. Premature systoles, however long established, should be regarded as an evidence of heart protest and an exhaustive search should be made for the underlying condition that excites the heart to premature contraction.

Case of mitral incompetency with frequent premature contraction of ventricular origin, as shown by the long pause, in which **discontinuance** of the **immoderate use of coffee and tea** was followed by decided improvement as to both frequency and severity of the premature contractions. **Fatigue** in sufferers from premature contractions should also be **guarded against**. While **digitalis** is contraindicated, as a rule, cases encountered in the stage of decompensation of chronic valvulitis may be distinctly benefited by the drug. In such instances it should be combined with small doses of **nitroglycerin**. In functional premature contraction, or that of reflex origin, one may find a predominating neurotic

element which must be combated; there is also often a history of the abuse of tea, coffee, alcohol, or tobacco. **Correction of the dietary** in cases due to indigestible and coarse foodstuffs sometimes proves effective. J. M. Anders (Med. Rec., Sept. 25, 1920).

Utility of **quinidine** pointed out. The mechanism by which this drug has done harm in some cases of auricular fibrillation, *viz.*, through dislodging of clots previously formed in the auricle by reason of the impaired auricular functioning, does not apply in other types of irregularities. In 60 per cent. of a series of patients with extrasystoles the writer obtained good results from quinidine sulphate. A woman of 56 who had been made extremely nervous by the irregularity, which had grown worse through several years, was placed on 0.75 Gm. (12 grains) of the drug 3 times a day after she had been in the hospital a week. Within 48 hours the irregularity had disappeared. The dosage was gradually reduced to 1 dose a day in the evening. The extrasystoles were thus kept down to at most 1 every 3 or 4 minutes, instead of occurring as often as every 2 or 3 beats. In a woman of 73 with a systolic aortic murmur and a premature contraction about every third beat, 0.2 Gm. (3 grains) of the drug after meals resulted in normal rhythm, though sodium bromide had previously proven ineffective. J. H. Musser, Jr. (Ann. of Clin. Med., Jan., 1924).

#### AURICULAR FIBRILLATION.

—Auricular fibrillation is a condition of the auricles in which some part of the auricular musculature is continually contracting, but in which the once orderly movement, involving the entire structure, becomes more or less incoördinate and therefore ineffectual. A view which has gained ground as to the cause of the disorder is one originally advanced by Mines, to the effect that the per-

verted auricular mechanism which is responsible for auricular fibrillation (as well as for auricular flutter) is, in all probability, due to a continuous circulating wave which travels in a circle or ellipse. The circle is believed to be around the mouth of the vena cava in the right auricle. Into this circle there enters an excitation wave, the crest of which rapidly follows upon its tail, leaving only a very small gap between the crest and the tail. Into the gap the crest of the wave continuously reenters and the *circus movement* is thus established, resulting in the fibrillation of the auricles.

**Etiology.**—Auricular fibrillation may occur in early life and in old age; it is seen most frequently, however, after the age of twenty-five. Probably 25 to 50 per cent. of the cases of auricular fibrillation occur in patients with rheumatic heart disease; and the most common associated valvular lesion is mitral stenosis, occurring usually after the age of forty-five or fifty. It is frequently associated with arteriosclerosis. Many cases of hyperthyroidism later develop auricular fibrillation. It may occur in pneumonia, in syphilis or be produced experimentally by poisons.

The predisposing factors include impaired irritability of the myocardium and early myocarditis, the latter often associated with sclerotic changes in the arteries and kidneys. Among the exciting causes are toxins, various alkaloids and perverted actions of the nervous system. Brief fibrillation may be the first obtrusive manifestation and occur comparatively early in progressive cardiovascular disease. The prognosis depends largely on the condition of the myocardium. R. V. Patterson (Jour. Amer. Med. Assoc., Feb. 9, 1923).

The age of 50 years was found to be generally the dividing line between the 2 commonest sources of auricular fibrillation, *viz.*, mitral stenosis (the type of cardiac disorder due to toxic goiter) and chronic myocarditis. Of his 51 cases, 17 had mitral stenosis and 7, toxic goiter. The electrocardiogram is often useful in the separation of the 2 groups. Right ventricular preponderance suggests mitral stenosis, while left preponderance is against it. The writer believes fibrillation is nearly always associated with changes in the heart-muscle, usually serious; these may, however, be physiochemical rather than gross structural changes. F. N. Wilson (Jour. Mich. State Med. Soc., Nov., 1923).

Case of auricular fibrillation in a child aged 10 years. The patient had had diphtheria, chicken-pox and influenza. Ogden (Amer. Jour. Dis. of Child., June, 1925).

**Pathology.**—The type of lesion found in the heart varies, but scattered foci of inflammation and degeneration are often present in the auricular tissue, and most marked in the specialized tissue. Other pathologic changes consistent with the associated heart involvement, as rheumatism and arteriosclerotic lesions, may also be present.

Transverse section, 10 microns thick, of the sinus node showed histologically that changes in the auricle may occur in fibrillation, but are only rarely causative. They may or may not be present without fibrillation, and other changes may be equally important. Brief and transitory fibrillation may apparently be due to functional changes in the cardiac nerves. G. Floystrup (Acta med. Scandin., lvi, 12, 1922).

There is no lesion in the auricles that could be looked on as the cause of auricular fibrillation. A slight degenerative lesion was found in the muscle fibers of the auricles much more frequently with auricular fibril-

lation than in regularly beating hearts of the same age. Frothingham (Arch. of Internal Med., Sept. 15, 1925).

**Diagnosis.**—The symptoms and signs of auricular fibrillation are an irregular rhythm of the heart and some degree of cardiac failure. The irregularity is an absolute arrhythmia and exercise tends to increase the irregularity—a point which distinguishes it from all other heart irregularities. The pulse varies in volume and in rate, and usually not all the beats heard by auscultation are propagated to the wrist; this condition is known as a *pulse deficit*. The ventricular type of jugular pulse is present and is often helpful in diagnosis.

Discussion of the *subjective symptoms* of distinct diagnostic value in the arrhythmias. A majority of the patients with auricular fibrillation could tell very definitely the time of its onset, the commonest symptoms being precordial pain, general weakness and sometimes dyspnea. Others observed were palpitation, gastric symptoms, a beating sensation in the abdomen, epigastric pain on exertion, dizziness, fainting and cerebral attacks. Some patients had developed rather suddenly a general weakness. Precordial oppression and discomfort in the pericardial region was the main complaint in 7 out of 20 cases. This cleared up promptly under digitalis even though the irregularity persisted. Often patients went from fibrillation to normal rhythm without any amelioration of the symptoms, showing the latter to be due rather to myocardial insufficiency than to the irregularity. Cases of auricular fibrillation with slow ventricular rate will go along for years in apparent perfect health. J. H. Musser, Jr., and T. McMillan (Penna. Med. Jour., Oct., 1922).

Gastric distress and vomiting accompanying the onset of fibrillation

may be wrongly ascribed to gall-bladder or appendix disease. While there are no symptoms characteristic of auricular fibrillation, at least  $\frac{1}{10}$  of the cases can be recognized without laboratory methods. J. D. Heard (Penna. Med. Jour., Oct., 1922).

Three cases in which syncope appeared to be due to the onset of paroxysmal auricular fibrillation. Importance of recognizing the sudden onset of auricular fibrillation as a cause of sudden unconsciousness emphasized. Clarke (Jour. Mich. State Med. Soc., May, 1925).

By use of graphic methods, the diagnosis is absolute and certain. The presence of an absolute type of arrhythmia, the arrhythmia increasing after exercise, with a heart rate of 120 and the presence of some degree of heart failure, are most valuable clinical signs. The occurrence of the ventricular form of venous pulse is of confirmatory value.

Study of the reaction to exercise of 9 hearts with auricular fibrillation in the absence of signs of failure. Each patient or control placed 1 foot on a chair 17 inches high and lifted himself up on the chair with it 20 times repeating the exercise with the other foot. The arrhythmic hearts showed a disproportionate rise in ventricular rate and delayed return to the pre-existing level. This delayed return was exhibited by the same patients even when the rhythm had been restored to normal, and was therefore not due to the fibrillation *per se*. Digitalis failed to protect the ventricles from the exaggerated response to exercise. When, in auricular fibrillation, the ventricular rate rises as a result of exercise, the auricular rate generally falls. H. Blumgart (Heart, Jan. 30, 1924).

**Prognosis.**—Auricular fibrillation usually is permanent, but may be transient or periodic. If at all persistent, it is reasonable to conclude



that important damage has been wrought in the myocardium. If the fibrillation is of the type that can be controlled by efficient treatment, the results are often very gratifying, but when the ventricular muscle has been impaired, improvement under treatment is not so satisfactory.

There is no convincing evidence that the physiologic changes underlying fibrillation necessarily depend upon serious organic heart disease, and various clinical observations indicate that sometimes the opposite is the case. A. W. Hewlett (Cal. and West. Med., Oct., 1924).

**Treatment.**—The first principle in the treatment of auricular fibrillation is to administer **digitalis** to the point of inducing sufficient heart block to prevent some of the shower of haphazard impulses coming down from the auricles from reaching their destination. Thus the ventricles are permitted more rest and have time to fill properly before contracting. The reduction of the pulse deficit, a pulse of sustained volume and a rather forceful systolic thrust at the precordium are the findings hoped for by digitalis administration. Other criteria of adequate digitalization, or of minor digitalis intoxication, are (1) nausea and vomiting; (2) fall of the heart rate to or below 60 beats a minute; (3) appearance of frequent premature systoles.

The main indications in auricular fibrillation are **absolute rest** and **digitalis**. The latter should be administered in every case in which, while the patient is at rest, the heart beat exceeds 100 per minute. As soon as reduction to this rate is accomplished the remedy should either be discontinued or greatly lessened in amount. In cases in which the disorder is extreme and the indications are to bring the heart under control quickly an in-

itial dose of 1 dram (4 c.c.) of the tincture may be given, followed by an equal amount in each 24 hours, divided into 3 or 4 doses. The rest period in bed should be prolonged beyond the relief of symptoms in order that the overworked ventricular myocardium may gain its tone and the functions of other organs be restored. **Purges** are indicated where visceral congestion exists and **venesection** as an emergency measure when there is danger of circulatory collapse. R. V. Patterson (Med. Rec., Mar. 26, 1921).

Four cases with electrocardiograms showing return to normal rhythm after treatment of auricular fibrillation. Among them were cases of advanced circulatory disease with high blood-pressure and complaint of dyspnea and pain, and of heart disease following prolonged overwork, with symptoms of angina pectoris. The measures used consisted mainly of **digitalis**, **diet restrictions**, and fortnightly doses of **castor oil**. L. F. Bishop (Amer. Jour. Med. Sci., Jan., 1923).

Clinical tests of the effects of massive doses of **digitalis** in fibrillating cases dyspneic on exertion but without obvious failure. The tincture was given to a total of 3 to 3½ drams (12 to 14 c.c.) in 12 hours' time. Usually the heart rate dropped in 12 hours after the initial dose, the average fall being 10 beats per minute. Next morning and later on that day a further fall of 10 beats occurred. The quality of the pulse was much improved. The total duration of the effect was from 4 to 14 days. There was no definite diuretic effect in any case. The patients all felt better and said they had less palpitation. Nausea and vomiting were never seen, and apart from occasional coupling of the pulse in 2 cases there were never any indications of overdosage. J. Jensen (Lancet, Apr. 12, 1924).

At times, particularly in acute cases, **digitalis** will lose its effect. This, according to Sajous, is due to exhaustion of the adrenals. In such cases he injects very slowly **adrenalin**, 7 minims (0.42 c.c.) of

the 1:1000 solution in a syringeful of saline solution, and repeats the dose at 3-hour intervals; or, as an alternative method of procedure,  $\frac{1}{40}$  grain (1 mgm.) of adrenalin in a triturate may be placed under the tongue.

The **desiccated suprarenal gland**, 2 grains (0.13 Gm.) every 4 hours, also tends, if the preparation is a satisfactory one, to restore the adrenal functional activity, after which **digitalis** may be resumed, along with the suprarenal product.

A standardized method of administering digitalis is called the "Eggleston method." It is designed for rapid digitalization by oral administration, and should be used only when the patient is under continuous medical observation, as when in a hospital. The amount of the drug used is expressed in terms of activity of the drug and the patient's body weight in pounds. The activity of the drug is determined by the cat method of Hatcher, the unit being that amount of the dry drug, expressed in milligrams, which is required to kill a cat weighing one kilogram when a solution is injected intravenously. The amount thus arrived at is called the *cat unit*. High grade specimens of digitalis when not assayed by the cat unit may be regarded as having an average activity corresponding to 100 milligrams to the cat unit.

The average total amount of digitalis required for oral administration in a man is 0.15 of one cat unit per pound of body weight, or  $1\frac{1}{2}$  c.c. (24 minims) of tincture per 10 pounds of body weight. The calculation of the average total amount required by any given patient is as follows: The patient's weight (W) is determined in pounds, the cat unit (C.U.) of the digitalis ascertained, and one of the following formulæ applied:

$$(1) \frac{C.U. \times 0.15 \times W}{1000} \text{ equals grams of dried leaf in total amount.}$$

$$(2) \frac{C.U. \times 0.15 \times W}{100} \text{ equals c.c. of tincture in total amount.}$$

$$(3) \frac{C.U.}{100 \times W} \text{ equals c.c. of infusion in total amount.}$$

In a patient weighing 150 pounds, and using digitalis with an activity of 100 milligrams to the cat unit, the 3 formulæ work out thus: 2.25 Gm. ( $34\frac{3}{4}$  grains) of the powdered leaf, 22.5 c.c. (365 minims) of the tincture, and 1500 c.c. ( $50\frac{3}{4}$  fluidounces) of the infusion.

From one-half to one-third of the total calculated amount is administered at the first dose. After an interval of 6 hours, from one-fifth to one-quarter of the total amount is administered; after 6 hours more, from one-eighth to one-sixth of the total amount, and thereafter one-tenth of the total amount every 6 hours until maximal digitalization is secured. In the case cited above, the total amount being 22.5 c.c. of the tincture, the first dose is 7 to 11 c.c. (114 to 178 minims); the second, 4 to 5 c.c. (65 to 81 minims); the third, 2.5 to 3.5 c.c. (41 to 57 minims), and thereafter 2 c.c. ( $32\frac{1}{2}$  minims) every 6 hours, if required.

It has been shown that when digitalis is given in sufficient amount, the therapeutic effect may be observed in 5 to 6 hours and the maximal action in 12 to 18 hours. The average individual body excretes about 22 minims of the tincture per day. The danger of the "cumulative action" of digitalis probably has been over-emphasized.

There are some patients with auricular fibrillation who are helped decidedly by **graduated exercise**, *vis.*,

the young or middle-aged, without valve lesions or history of heart-failure, but complaining of palpitation on exercise or mental excitement; the cardiac reserve power is not markedly decreased. In 1 case of protracted fibrillation following influenza in a man of 36 years, in whom swinging a 10-pound dumbbell 20 times raised the heart-rate to 162, with dyspnea, 2 months of graduated exercise by swinging dumbbells caused great improvement in all respects, with ability to swing 15-pound dumbbells 30 times without distress or abnormal circulatory reactions. Upon taking only 3 doses of **quinidine sulphate** of 0.4 Gm. (6 grains) each, his heart became regular and was still regular 2½ years later. In another class of patients, with the reserve power much decreased, **digitalis** is required. In 1 such case, 53 years of age, slow progress was made in 6 weeks under **digitalis** and swinging 5- and 10-pound dumbbells, but upon restoration of sinus rhythm by a total of 11.7 Gm. of quinidine in 6 days, the same amount of progress on exercising was added in 11 days. He continued taking 0.5 Gm. (7½ grains) of quinidine sulphate daily. T. B. Barringer, Jr. (Jour. Amer. Med. Assoc., Feb. 16, 1924).

Another drug, **quinidine**, has been used with good results in carefully selected cases. This agent should not be administered to walking patients; a physician should constantly supervise the administration of quinidine. The preferable cases for its use are those of relatively recent inception, which exhibit no evidence of the congestive type of failure, and in which the ventricular rate is not over 100 beats per minute.

Quinidine slows conduction in the auricles and prolongs the period in which the auricle is refractory after contraction. By this means, the drug may abolish the circus movement responsible for fibrillation, through per-

mitting the wave in the circus to close up the gap and run into an area of tissue still refractory, following contraction in response to a wave in the previous circuit. The drug, like atropine, paralyzes the vagus nerve and thereby shortens conduction between auricles and ventricles, and also causes a lengthening in the conduction by direct action on the bundle of His. These are opposing effects, the extent varying in different individuals. Paralysis of the vagus nerve accounts for the increase in ventricular rate observed when quinidine therapy is employed.

Some hearts that have been restored to normal mechanism by quinidine may later relapse, and the good results appear to be uninfluenced by sex, age, presence or absence of a valvular lesion, etiologic type of heart disease, etc. Marked relief usually is experienced on return of normal rhythm, although some patients show no conspicuous benefit. A probable explanation is that though the normal sino-auricular rhythm has been restored, extensive impairment of the heart may be present; quinidine, of course, cannot remove the lesions associated with rheumatic, syphilitic or arteriosclerotic heart disease.

The simultaneous administration of **digitalis** with **quinidine** is often of great advantage to keep the ventricular rate at a low level throughout the quinidine reaction. In some cases a course of **digitalis** immediately preceding the quinidine is indicated, even though rather heavier doses of the latter must be given. An increase in the ventricular rate is a part of the reaction, but a rate as high as 160 would be a contraindication to quinidine.

Dilatation of the heart and symptoms of embolism are likewise con-

traindications. Thomas Lewis (Amer. Jour. Med. Sci., June, 1922).

Report of 11 cases, in 5 of which quinidine caused a lasting restoration of normal rhythm. **Quinidine sulphate**, with proper case selection, may be given to digitalized cases of fibrillation almost, if not quite, as safely in private practice, under the guidance of the family practitioner, as in the hospital. The writer had 1 fatal case, however, in which the drug led directly to cerebral and cardiac complications. This case illustrated the danger of giving quinidine in cases with venous thromboses, *e.g.*, varicose veins with phlebitis, etc. S. Neuhof (Med. Jour. and Rec., Sept. 3, 1924).

Case of a woman, aged 52, with auricular fibrillation, who was kept very comfortable on a certain amount of **quinidine sulphate** every day. She took 6 grains (0.4 Gm.) at 10 A.M. and 10 P.M., this maintaining a regular rhythm. The drug kept her free from pain (an unusual complication in auricular fibrillation) and abolished recurrent attacks of acute fibrillation with rapid rate. In 2 other cases the maintenance of a regular rhythm by such a ration of quinidine kept the patients free of edema. Talley (Atlantic Med. Jour., Jan., 1926).

The usual method of administering quinidine is as follows: The heart is first brought under control by the use of **digitalis**, relieving the symptom of heart failure and offsetting to some extent the quinidine effects on atrio-ventricular conduction later to be expected. When there is no longer any congestive type of failure and the ventricular rate is perhaps 100 or less, digitalis is discontinued for 3 or 5 days to permit any possible excess of that drug to be eliminated. Quinidine sulphate in capsules of 3 grains (0.2 Gm.) is then administered orally. When no untoward symptoms occur within a few hours, it is likely that the patient is not hypersensitive

to the drug, and the following day a dose of 6 grains (0.4 Gm.) of quinidine sulphate is administered every 4 hours. This may be continued from 5 to 10 days. When beneficial effects are obtained they usually occur within the first day or two. If the normal rhythm is not restored at the end of 10 days, the drug is discontinued for the same period of time, after which a second course may be instituted. If, however, the normal rhythm has not been restored in the first course, there is little likelihood of success in the succeeding trials.

After restoration of the normal rhythm, the drug should not be reduced too suddenly. The cases that seem to maintain normal rhythm the longest are those that are kept indefinitely on small doses of from 3 to 6 grains a day. If, after having the normal rhythm restored, the patient again reverts to fibrillation, it may be possible again to restore the normal rhythm by the same procedure.

Among 11 cases, **quinidine** caused 5 to resume regular rhythm, but only for a short period in 1. The type of lesion appears to be of less importance than the degree of decompensation, but the dose necessary varies greatly, some patients being unusually susceptible to it. A small preliminary dose is therefore recommended, 3 grains (0.2 Gm.) 3 or 4 times on the first day, not exceeding a total of 31 grains (2 Gm.) in 24 hours. The return to normal rhythm sets in usually about the third day, the general condition of the patient being frequently improved. But quinidine may produce alarming symptoms, and may affect compensation unfavorably. Several fatalities have been reported. It should be given, according to the writers, only after decompensation has been treated by other methods, and when the patient is kept under care-

ful observation. Hewlett and Sweeney (Jour. Amer. Med. Assoc., Dec. 3, 1921).

Report on 25 cases. Where **rest in bed**, a **salt-poor diet** and **limitation of fluids** to 1000 c.c. a day for 3 days failed to improve, drugs were given, some cases receiving **digitalis** first and **quinidine** after the symptoms of heart-failure had subsided, while others were given quinidine at once. Test doses of 0.2 Gm. (3 grains) were first given; then, the next day, 0.4 Gm. (6 grains) every 2 hours for 5 doses unless normal rhythm reappeared or toxic effects occurred; if these results did not occur the same dosage was continued for a week. Of 22 cases of persistent fibrillation, 63.6 per cent. were restored to normal rhythm, including all of 9 arteriosclerotic cases and 41 per cent. of 12 cases of rheumatic etiology. Patients fully digitalized responded to quinidine just as often as others. Untoward symptoms such as tinnitus, vertigo, nausea and palpitation occurred in 40 per cent. of cases. One case developed sudden, but transient cardiac collapse. Two cases died—1 suddenly and the other after coma and slowed respiration—about 12 hours after the last dose of quinidine. J. Wyckoff and M. Ginsburg (Boston Med. and Surg. Jour., May 8, 1924).

No relationship could be noted, in a series of 52 cases, between the amount of **quinidine** used to convert the rhythm and the degree of heart block found present after the normal sinus rhythm had been established. The total amount needed to induce a sinus rhythm in most cases was quite small. In only 2 of 41 successfully treated cases were more than 5 Gm. (75 grains) of quinidine used, and in 25 cases not more than 3 Gm. (45 grains). The probability of success diminishes very rapidly after more than 5 Gm. have been given.

In a few exceptional cases quinidine was given in the presence of a considerable degree of decompensation, with excellent results. In 1 case it seemed to cause a respiratory paralysis, fortunately transient.

The length of time fibrillation has existed is not of much prognostic value with reference to successful treatment. Neither the kind of heart disease nor the amount of decompensation experienced seems to have any relation to the success or failure of the treatment.

The use of digitalis in the after-treatment of these cases seems to be even more important than that of quinidine. Both the temporary and permanent conversion of the fibrillation to a normal sinus rhythm by quinidine seem to be favorably influenced by the presence of a delayed conduction time at the auriculoventricular junction. Careful management of cases as to exercise, mental excitement and fever during quinidine administration greatly facilitates the favorable action of the drug. Quinidine is most effectual when given continuously through the day and night. Riecker (Amer. Jour. Med. Sci., Aug., 1925).

The symptoms of the toxic action of quinidine are essentially those of quinine, *viz.*, ringing in the ears, headache, nausea, vomiting, palpitation (tachycardia), delirium, etc. Respiratory paralysis may also ensue. The maximum effect of the drug is secured about 2 hours after it has been administered, and the effect disappears in from 12 to 18 hours. Patients undergoing quinidine treatment should be in bed and seen often by the physician in order to avoid the continuance of the drug after the appearance of toxic symptoms. Disaster may occur as a result of the throwing off of an embolus from the heart. It is known that auricular thrombi are more common when fibrillation is present. According to Cabot, 25 per cent. of the fibrillating auricles that come to autopsy are found to contain thrombi. The restoration to normal rhythm increases

the chance of embolism, which renders the prognosis always guarded in auricular fibrillation.

Indications and contraindications to **quinidine** specified as follows: (1) It should not be given if emboli have occurred. (2) Any decompensation should be treated by the usual methods before using it, and unless there is improvement quinidine should be given cautiously or not at all. (3) It is indicated in fibrillation of recent onset and where signs of marked decompensation are absent. (4) If normal rhythm is re-established, it is well to continue small doses of quinidine for weeks or months. If the foregoing rules are followed the danger from quinidine is slight and the results from it often striking. A. W. Hewlett (Cal. and West. Med., Oct., 1924).

**AURICULAR FLUTTER.**—Auricular flutter is a condition in which the auricle contracts regularly at a rate usually between 250 and 300. It was formerly considered a very rare condition, and, comparatively, still is, although since instruments of precision are being used so routinely flutter is nowadays detected more frequently. This condition was in the past diagnosed as tachycardia or as some type of irregularity.

Flutter may be present at as early an age as five years, but usually occurs between thirty and sixty years. Seventy-eight per cent. of the patients are males. Conditions associated with auricular flutter are arteriosclerosis, coronary sclerosis, rheumatic heart disease and syphilis.

The mechanism of auricular flutter is the same as that described under fibrillation, *viz.*, the circus movement, the difference being that in flutter the multiple waves are given off at regular intervals, while in fibrillation the waves are irregularly propagated to the auricular muscle.

Many of the patients are found to have been subject for some years to the momentary sensation accompanying an occasional premature systole or a short run of premature systoles, but otherwise to have been in fair health. The symptoms of flutter are palpitation and some degree of cardiac embarrassment. The onset is sudden and the cessation gradual. The ventricles rarely beat at the same rate as the auricles, though such cases have been reported in literature. Some degree of heart block is likely to be present. An irregularity may occur due to a shifting from 2 to 1 to a 4 to 1, etc., rhythm, in the relation between auricular and ventricular contractions.

**Diagnosis.**—Instruments of precision, preferably the electrocardiograph, are essential to an accurate diagnosis of this condition. *Paroxysmal tachycardia* differs in that it does not tend to the permanency that is a feature of flutter. The abrupt termination and response to vagus stimulation so often noted in paroxysmal tachycardia are not characteristic of auricular flutter. The pulse is always regular in paroxysmal tachycardia, but not necessarily so in flutter. The possibility of simple heart block may occur when the ventricular rate in flutter is irregular. The auricular heart sounds may be heard in block but not in flutter.

Flutter may be suspected in a patient with a pulse rate of 140 to 160 in whom after exercise the rate suddenly changes to some multiple of the pre-exercise rate, or when the rate becomes slower and irregular after exercise. An electrocardiogram will clear up any question as to diagnosis.

In 1200 electrocardiographic examinations, the writer observed 137 cases of auricular fibrillation, 15 of paroxysmal tachycardia and 9 of auricular flutter. A clinical diagnosis of the latter can be made with assurance in many cases. It should be suspected in any regular tachycardia with a rate between 140 and 160. It occurs usually in adult males and is not commonly associated with chronic valvular disease, although it may occur in any type of heart lesion. It can frequently be recognized clinically by varying ventricular rhythms, one slower and irregular when at rest, and the other a regular tachycardia on excitement or exertion. If pressure on the vagus in the neck causes an irregular ventricular block, this will differentiate flutter from paroxysmal tachycardia. Fluoroscopy showed the condition of flutter in 4 out of 5 cases.

The associated symptoms of flutter are dyspnea and palpitation, but it is less of a circulatory handicap than fibrillation. It seems certain that palpitation may result simply from increased auricular activity, for it continued in spite of slowing of the ventricular rate. A. M. Wedd (*Ann. of Clin. Med.*, July, 1924).

Importance of electrocardiography in the diagnosis of auricular flutter illustrated in the writer's case in which, without it, the condition would have been overlooked. An incomplete right bundle block, which persisted after return to normal rhythm, was also present. Digitalis alone failed in this case, but rapid improvement occurred on Guy's pills of **mercury**, **squill** and **digitalis**, suggesting that the condition may have been one of syphilitic involvement of the heart. W. N. Horsfall (*Med. Jour. of Austral.*, Mar. 15, 1924).

**Prognosis.**—Flutter of the auricles has been known to persist for several years. It may be transient, and in some patients it is the precursor of fibrillation. Commonly it is indicative of serious involvement of the

heart and the expectation of life is shortened. The severity of the condition depends entirely on the ventricular rate; if this reaches 300 per minute, the patient probably will lose consciousness.

**Treatment.**—This consists in the administration of **digitalis** to the point of increasing the grade of heart block, some degree of which usually is present in flutter. In many cases auricular flutter will thereupon change to auricular fibrillation; then, when digitalis is discontinued, normal rhythm will follow. This sequential change in rhythm does not always ensue; nevertheless, digitalis by increasing the heart block diminishes the ventricular rate, and cardiac failure is thus averted. During the paroxysm, the patient should be at **rest in bed**, even though the cardiac reserve be good and palpitation the only symptom. Should symptoms and signs of cardiac failure ensue, absolute rest in bed is essential. In the average case without grave symptoms, 20 minims (1.25 c.c.) of the tincture of digitalis, or a corresponding dose of the powdered leaf or infusion, should be given 3 times a day—more often in serious cases. If symptoms are urgent, **strophanthin**,  $\frac{1}{30}$  to  $\frac{1}{60}$  grain (0.0005 to 0.001 Gm.), or **crystallized digitalin**,  $\frac{1}{500}$  grain (0.00013 Gm.), should be given intravenously, while 30 minims (2 c.c.) of tincture of digitalis should be given by mouth and repeated every 4 hours. The beneficial effects of strophanthin given intravenously are most striking.

In flutter the writer recommends **digipuratum**, 0.1 Gm. ( $1\frac{1}{2}$  grains) thrice daily, then  $\frac{1}{2}$  this dose after the disorder has been overcome, to prevent its return. To prevent any

untoward effects due to prolonged intravenous use of digitalis or strophanthin, he gives also 0.5 mgm. ( $\frac{1}{20}$  grain) atropine. In some he gives, in addition to digitalis, **quinine sulphate** and **strychnine**. In cases of short duration he uses **quinidine**, beginning with 0.2 Gm. (3 grains) 2 to 3 times daily, but this remedy sometimes produces toxic effects. Klewitz (Berl. klin. Woch., Aug. 5, 1922).

Case of flutter in which there had been for 10 years attacks of dyspnea, palpitation and edema; **digitalis** given for a month in conjunction with **quinine sulphate** restored the heart action to normal. O. Montoro (Rev. med. cubana, Aug., 1923).

In the treatment of flutter, the writer prefers **quinidine** to digitalis, on the ground that the best method of terminating a circus movement is to lengthen the refractory period of the auricle, thus making re-entry of this disturbance impossible. The preliminary production of fibrillation should preferably be avoided, and attempts made to convert flutter directly to normal rhythm by **quinidine** or a combination of it with **digitalis**. With the **quinidine** following the **digitalis**, the latter will protect against an excessive ventricular rate during administration of **quinidine**. Normal rhythm was restored by **quinidine** in 3 out of 6 cases. In 1 case, a single dose of 0.8 Gm. (12 grains) sufficed. A. M. Wedd (Ann. of Clin. Med., July, 1924).

**HEART BLOCK.**—The term heart block implies that the impulse for contraction, as it travels from the top of the auricle to the muscle fibers of the ventricle, is blocked somewhere in its course. The block may be nothing more than a simple hesitation in the discharge of the impulse from the sinoauricular node (pacemaker); or it may be so complete that no impulse whatever gets through from the auricle to the ventricle, and in that event the ventricles initiate a

slow rhythm of their own and act in total independence of the usual auricular impulse.

The types of heart block are (1) sinoauricular block; (2) low-grade block; (3) incomplete block; (4) complete high-grade block.

The conducting tissue may vary in its functioning in accordance with the sinus rhythm, local metabolism or central or peripheral nervous factors. There is also the possibility of a *reversed* type of block, in which, although block of impulse condition from auricle to ventricle is complete, impulses may travel in the opposite, upward direction. The writers observed this in 2 cases. P. Veil and J. Codina-Altès (Arch. des mal. du cœur, Dec., 1923).

**Symptoms.**—The signs and symptoms vary considerably. Many patients whose lives are not too strenuous may be remarkably comfortable with heart block. Some degree of heart failure is, however, usually present.

In a series of 35 cases of block of the branches of the auriculoventricular bundle, 18 had dyspnea on slight exertion and 17 even when at rest; in 8 it had existed over 2 years, in 10 over 1 year and in 17 less than 1 year; 12 had cardiac asthma; 10 anginal pains, of sufficient severity in 4 to require morphine; 20 had swelling of the feet. Thus, all had symptoms of myocardial weakness, while 17 gave signs of marked cardiac disease. Herrick and Smith (Amer. Jour. Med. Sci., Oct., 1922).

It is not uncommon for symptoms referable to the nervous system to predominate. In such cases a marked slowing in rate, or even ventricular standstill, may produce a cerebral anemia. The symptoms, depending on the length of the attack, are pallor, transient giddiness, dimness of vision, momentary loss of vision, and, perhaps, convulsions progressing in



severity until death. There is little disturbance if the ventricular silence lasts but 2 or 3 seconds; but if the pause is from 3 to 5 seconds, twitchings or convulsions appear, the breathing deepens, and cyanosis gradually develops. Should the heart function be held in abeyance from 90 to 120 seconds recovery is rarely witnessed. The term **Adams-Stokes syndrome** has been applied to seizures of the type just described, featured by slow ventricular rate, syncope and epileptiform convulsions.

While any grade of heart block may persist without developing the Adams-Stokes syndrome throughout the patient's life, the seizures constituting the syndrome—a sudden marked slowing of the usual pulse accompanied by attacks of unconsciousness with or without convulsions—occur most frequently in subjects suffering from permanent progressive complete heart block. They also occur in incomplete dissociation with a permanent idioventricular rhythm well established. The immediate cause of the seizures may usually be traced to some unusual physical activity. The cause of the seizures, whether confined to unconsciousness or accompanied by fits, is sudden cerebral anemia, due to the abrupt slowing of the ventricular rate. Mild attacks are marked by vertigo, faintness, pallor, loss of consciousness and absence of ventricular beat. Severe seizures occur where the ventricular standstill lasts 15 seconds or more. Here venous engorgement causes pallor, cyanosis, unconsciousness, twitching of the face or an arm, and occasionally the fits become generalized. In these attacks the patients do not pass urine or bite the tongue. In the mild cases, breathing may be normal; in the severe attacks, stertorous and apneic. The only suggestion of an aura is that at times the patient is aware of the slowing of the ventricular rate, with varying pauses between beats, from a normal rate to

one of 30 per minute. The outlook depends upon the extent of the myocardial degeneration and the frequency and severity of the fits. Sudden death in a first attack is rare. The majority of these patients die of progressive heart failure. J. E. Talley (*Med. Rec.*, Nov. 27, 1920).

Case in which, during attacks to which the patient, a man of 69, was subject, the auricular beat fell to 15 and was completely dissociated from the ventricular. The latter ceased at times altogether, once for 11 seconds, which led to fainting spells or epileptiform attacks. Josué (*Bull. de l'Acad. de Méd.*, June 6, 1922).

Case of intermittent complete block. Syncopal attacks during the block were found due to ventricular standstill for 6 to 20 seconds. Such attacks followed administration of digitalis. In this instance changes in nodal and ventricular rhythmicity appear to be the governing factor in producing standstill, while definite vagus and auricular influences are absent. Gager and Pardee (*Amer Jour. Med. Sci.*, May, 1925).

**Etiology.**—Any condition that interferes with the normal orderly transmission of impulses from auricle to ventricle produces heart block. Thus it has been produced experimentally by squeezing parts of the bundle of His between forceps in laboratory animals. Many poisons impair the conduction; notably digitalis, strophanthin, aconite, muscarine, physostigmine, nicotine, potassium salts, morphine and adrenalin. The latter two act by way of the vagus nerve, while the others act directly on the conduction tissue. Block may also occur in asphyxia, anaphylaxis, and is notoriously frequent in diphtheria. Among the clinical causes are syphilis, arteriosclerosis, rheumatic heart disease and the loose administration of digitalis.

Heart block and Adams-Stokes syndrome observed in a boy of 6 years, with the ratio 3:1 and pulse, 40. He had been healthy until the preceding 6 months. Bosanyi (Jahrb. f. Kind., Sept., 1922).

Impaired blood-supply to the conduction system may be a cause of some instances of heart block, especially those of a transient or functional nature. The writer observed marked reduction of conductivity in a case of large pericardial effusion in a man of 57; upon vagus pressure a 2:1 block was readily produced. Upon withdrawal of 500 c.c. of fluid from the pericardium the block disappeared, the systolic pressure at the same time receding from 190 mm. to normal. He ascribes the block to the pressure of the effusion on the coronary arteries and veins, as well as to the further coronary embarrassment due to compression of the auricles. L. T. Gager (Arch. of Int. Med., Apr., 1924).

In the writer's series of cases, arteriosclerosis was present as a factor in complete heart block in 62 per cent., rheumatic fever in 19 per cent., diphtheria in 19 per cent., and influenza in 3 per cent. There was no proved instance of syphilis. Probably areas of calcification in the bundle are responsible in many of the arteriosclerotic cases. F. A. Willius (Ann. of Clin. Med., Aug., 1924).

**Pathology.**—The pathological findings are inconstant and depend largely on the cause. Destruction of the bundle of His may be found, either partial or complete. If the condition results entirely from vagus action, from digitalis or from poisons, the toxic block may be transient and no lesion recognized by the pathologist. It is rare that the lesion is limited to the conducting tissue alone. Other parts of the heart are also involved, exhibiting the changes associated with syphilis, rheumatic infection, arteriosclerosis or other degenerative diseases of the myocardium.

At the necropsy of a case of complete heart block the writers found complete destruction of the bundle of His, the damage being almost limited to the junctional tissues, including the upper part of the 2 main branches of the bundle. The heart had evidently been contracting for years with no connecting link between the auricles and ventricles. Waldo and Herapath (Lancet, Feb. 11, 1922).

Case of heart block due to gumma of the ventricular septum. *Spirochæta pallida* was demonstrated in the ventricular tissues. Gall-bladder infection may be a primary or accessory cause of heart block. In a case described, the heart regained and maintained normal sinus rhythm after removal of an infected gall-bladder. Clarke and Smith (Amer. Jour. Med. Sci., June, 1925).

**Diagnosis.**—When heart block is complete, the pulse and ventricular rhythm are regular and of a rate averaging from 30 to 40 beats per minute. Higher and lower rates may prevail. During diastole of the ventricle the multiple auricular contractions can sometimes be heard, and multiple waves may be seen in the veins of the neck (due to auricular activity) which are more rapid than the ventricular or pulse rate. Following exercise, shortness of breath appears quickly in complete heart block, and there is little if any increase in the pulse rate. In other grades the symptoms and signs vary according to the degree of heart muscle involvement present.

Case in which the ventricular rate was 18 in the morning and 12 to 14 in the evening. On brisk walking it dropped from 18 to 10, the latter rate continuing for several hours. C. Laubry and A. Mougeot (Bull. Soc. méd. des hôp. de Paris., Mar. 17, 1922).

Latent disease in 1 of the branches is readily ascertained by the test

ARRHYTHMIAS DUE IN PART TO ADRENAL OVERACTIVITY. (*Sajous.*)

*The italicized lines represent the salient morbid features to be met therapeutically.*

## DIAGNOSIS.

**ALTERNATING PULSE.**—Pulse regular but weak every alternate beat. Usually met in elderly; often associated with angina pectoris, or anginal pains and dyspnea. Unfavorable sign if organic heart disease present and if heart rate normal, weaker beat indicating failure of ventricles, particularly if blood-pressure high, owing to vascular or renal disease. Not commonly observed.

**HEART-BLOCK.**—Pulse very slow; rate below 40 pathognomonic. May occur after physical and mental strain in normal subjects. In others, dyspnea, orthopnea, palpitations on exertion, anginal pains, edema, anasarca, vertigo, fainting, and convulsions may occur. First and second sound difficult to differentiate. Jugular curve significant. A common condition.

**PREMATURE CONTRACTIONS.**—Prolonged pause between beats due to premature contraction of ventricle or auricle, thus coupling beats. May follow 2 normal beats (pulsus bigeminus) or occur only once in a while. Usually ceases during exercise or while holding the breath. Increased by heavy meals and fatigue. May be a precursor of flutter or fibrillation.

## PATHOGENESIS.

Due: 1, to hyperadrenia and overexcitation of the nodes and bundles, caused by overexertion, worry, excessive use of tobacco and other adrenal stimulants, toxic wastes or toxins, uremic poisons, arteriosclerosis, etc., which raise vascular tension, and 2, to organic disease of the heart with myocardial degeneration from acute, chronic or focal infections. *Vascular hypertension with degenerated myocardium.*

Due also to hyperadrenia from same causes as alternating pulse, likewise to infections during the acute febrile period, and 2, to degenerative disorders of the myocardium, rheumatic and luetic disorders especially, which impair its contractile power and the coöperative efficiency of the auricles and ventricles. *Vascular hypertension with weakened myocardium.*

Due to hyperirritability of the nodes and bundles and of the endocardium due to abuse of tobacco, coffee, tea, digitalis, etc., and acute and focal infections which promote overactivity of the adrenals and tend to raise the vascular tension. Mainly observed in the aged, but not necessarily threatening to life if cause eliminated. *Adrenal overactivity with normal myocardium.*

## TREATMENT.

Digitalis contraindicated. Elimination of primary cause—toxic focus of infection, overwork, etc.,—of adrenal overactivity; **rest** and **low protein diet**. If adrenal and myocardial exhaustion present, indicating advanced stage with low blood-pressure, **nutritious diet** and **suprarenal gland with digitalis** or **strophanthus** to be given guardedly, beginning with small doses, solely to sustain the heart.

Digitalis contraindicated. In acute diseases with convulsions, **amyl nitrite** inhalations and **nitroglycerin** internally or **spiritus æthylis nitritus** in children, to ward off attacks. In chronic cardiac cases, removal of cause and **rest**. **Low protein diet** and **atropine** to reduce hypersensitiveness of nerve ends.

Digitalis contraindicated. **Sodium bromide** to reduce the cardiac hyperirritability, with abstention from tobacco, coffee and other adrenal irritants, and removal of causal disorder, after which normal rhythm returns. **Rest**, a **milk diet** for a few days, then **low protein diet** for a time until blood-pressure normal. If insomnia, **chloral hydrate** on retiring.

ARRHYTHMIAS DUE IN PART TO ADRENAL INSUFFICIENCY. (*Sajous.*)

*The italicized lines represent the salient morbid features to be met therapeutically.*

## DIAGNOSIS.

**AURICULAR FIBRIL-LATION.**—Pulse very irregular in rhythm, volume and rate; heart and pulse rates may differ, causing missed beats. Average rate 100 or more. Heart enlarged laterally; neck veins engorged and irregularly pulsative. Hoarseness, facial suffusion and cyanosis; heart failure and edema; fainting spells. All increased by exercise. Occurs in 60 per cent. of heart failure cases.

**AURICULAR FLUT-TER.**—Pulse very rapid and wavy but regular; liable to drop suddenly to one-half or one-quarter rate, due to dissociation of ventricular from auricular beats. Corrected by exercise. Dyspnea, feeling of impending suffocation, palpitations, vertigo, faintness, unconsciousness, convulsions as case progresses. Jugular pulse may show wavelets. Relatively rare.

**SINUS ARRHYTH-MIA.**—Pulse rate increased during inspiration and decreased during expiration, but normal when breath held. Disappears during exercise, recurs after it. Sometimes occurs in neurasthenia.

## PATHOGENESIS.

Due to two associated disorders: 1, hypoadrenia, the adrenal secretion being required to sustain the functional activity of the nodes and bundles, and 2, cardiac failure, functional, organic or valvular, mitral stenosis especially. Also due to infections, acute, chronic or focal, affecting both the adrenals and heart. *Vascular hypotension with myocardial failure.*

Due also to hypoadrenia and cardiac failure, from same causes as fibrillation, but with senile atrophy of adrenals and arteriosclerosis as more prominent factors. Atrophy of the adrenals reduces their secretory activity and the excitation of the auricular nodes, first reached by the secretion. Mainly a functional disorder. *Adreno-myocardial failure.*

Not regarded as pathologic, but its recognition is important to avoid giving unfavorable prognosis. Attributed by some to hypothyroidia when it occurs in children and to excess of tobacco in adults. *Cardiovascular atony.*

## TREATMENT.

**Digitalis** sovereign remedy, with absolute rest in bed until pulse below 90. Digitalis continued after leaving bed, in doses only sufficient to maintain slowed pulse; **suprarenal gland** to offset adrenal insufficiency. **Quinidine** effective in 50 per cent. of cases. In acute cases  $\frac{1}{60}$  grain (0.001 Gm.) **adrenalin** triturate under the tongue. **Vitamin foods** (see Vitamins).

**Digitalis** converts flutter into fibrillation, then restores normal rhythm. **Suprarenal gland**, **strychnine** or **atropine** first to be tried. Normal rhythm may then recur without causing fibrillation. In acute cases  $\frac{1}{60}$  grain (0.001 Gm.) **adrenalin** triturate under the tongue. **Vitamin C foods** (see Vitamins) and carefully regulated ex-

Drugs contraindicated. In adults, **cessation of smoking** to test effects of tobacco; if neurasthenia present, **suprarenal gland** and **strychnine**. If stigmata of hypothyroidism clearly present, **thyroid gland**.

which consists in making pressure on the eyeball and thus exciting the vagus. Disturbed function of the bundle of His was produced in 1 healthy subject, but this is a rare result. Danielopolu and Danulesco (Arch. des mal. du cœur, June, 1922).

Among 37 cases of complete block observed at the Mayo Clinic, the greatest incidence was in the 7th decade of life, in which there were 18 cases. The youngest case was 22 years, and the average age, 53. Twenty-four cases were in males.

Twenty patients (54 per cent.) had the Adams-Stokes syndrome; 6, congestive heart-failure; 6, merely dyspnea on exertion; 3, angina pectoris. Twenty-nine patients (79 per cent.) had distinct cardiac enlargement, and 7, slight enlargement. Seven had chronic endocardial valvular disease, while the remaining 30 all had systolic apical murmurs transmitted to the axilla, probably the result of left ventricular dilatation. The range of ventricular rate was from 22 to 48. Adams-Stokes seizures occurred in all 6 cases with the rate in the 20's, in 59 per cent. of the 17 cases in the 30's, and in 36 per cent. of the 14 cases in the 40's. The auricular rate ranged from 50 to 107. (In a few reported cases, the ventricular rate has exceeded the auricular in spite of complete block). The average systolic pressure was 166; diastolic, 72, and pulse pressure, 94; the strikingly high pulse pressure probably results from the increased output at each beat. Electrocardiograms pointed to left ventricular preponderance in 70 per cent. of the cases. Of 22 patients subsequently traced, 15 died from heart disease in an average of 7 months after examination; in 5, death occurred in Adams-Stokes attacks. The prognosis in complete block depends less on the block than on myocardial integrity and the occurrence of Adams-Stokes attacks. F. A. Willius (Ann. of Clin. Med., Aug., 1924).

For conclusive evidence instruments of precision must be employed, in particular the electrocardiograph, which leaves no doubt as to the type of the existing condition. Without this instrument the degrees and varieties of block cannot be differentiated.

*Intraventricular block*, i.e., delay or blocking in the conduction system below the bifurcation of the bundle of His, was found by the writers to be of greater clinical significance than auriculoventricular block. Of 3219 cases electrocardiographed in a large hospital,

the former condition was found in 130 and the latter in 156. The 130 cases comprised 41 of the more severe type, *bundle branch block*, i.e., high grade block of 1 of the 2 main branches of the bundle of His, which supply the left and right ventricles, respectively. The remaining 89 cases were of lesser degrees of intraventricular block, consisting of either partial block in the main branches or extensive lesions in the finer arborizations or both. The greater importance of intraventricular block, which requires electrocardiography for its detection, lies in that the mortality from heart failure in 7½ years was higher in the cases with intraventricular block than in those with auriculoventricular block. Angina pectoris was 4 times more frequent. Arteriosclerosis was apparently responsible in 80 per cent. of the higher grade and in 59 per cent. of the lower grade of intraventricular block, and rheumatic fever and syphilis in smaller numbers of cases. Of the 41 cases of the bundle branch type, the right branch was affected in 40 and left in but 1. Eleven cases of sinoauricular block were also encountered. P. D. White and L. E. Viko (Amer. Jour. Med. Sci., May, 1923).

Strikingly distinctive ventricular complexes are met with in the electrocardiogram in bundle branch block. In these cases the picture of *right-sided* or *left-sided preponderance* is not produced by increase in weight of the corresponding ventricle, but by defective conduction of impulses to the opposite ventricles. D. Hall (Brit. Med. Jour., May 3, 1924).

The writers obtained a tracing of *ventricular fibrillation* in Adams-Stokes attacks in a woman of 55. The rate of ventricular fibrillation was 336. Abrupt cessation of this fibrillation accompanied return to consciousness. The patient lived a year before succumbing in an attack. L. Gallavardin and A. Bérard (Arch. des mal. du cœur, Jan., 1924).

*Sinoauricular block* is attended simply by a complete absence of one cycle;

through some defect in vagal control, the pacemaker does not send out an impulse. The auricle does not contract when expected, nor does the ventricle. Clinically, sinoauricular block has no significance and may be regarded as nothing more than an exaggerated sinus arrhythmia. It is probably of vagal origin and does not require treatment. It can be made to disappear by giving **atropine**.

Heart block may occur in normal individuals. Fourteen cases of sinoauricular block observed in recruits. It followed physical exertion, mental or emotional strain, or the use of certain drugs, and was independent of any infective process. In such cases the pulse becomes irregular as the normal rate returns after exercise and, unlike sinus arrhythmia, does not disappear when the breath is held. S. Calvin Smith (Amer. Jour. Med. Sci., Oct., 1921).

*Delayed conduction* is a condition in which there is merely a delay in response of the ventricle to the stimulus from the auricle. Clinical findings are nil. The condition may be the forerunner of higher grades of block; therefore, graphic records are indispensable. In mitral stenosis the delay may be recognized by a separation of the presystolic murmur from the first sound of the heart. This is spoken of as a mid-diastolic murmur. Occasional "dropped beats" or pulse intermission may be due to the auricular stimulus failing to elicit a ventricular response, and a clinical suspicion of this condition may be aroused by observing that during the pause the ventricular sounds are absent. This is not an entirely dependable sign, for frustrate ventricular systoles may also occur without any audible sounds.

A slow regular rhythm of 50 or less

is strongly suggestive of complete heart block, as is also galloping rhythm.

Congenital heart block, proven by graphic records, has been reported in 13 instances. Patency of the inter-ventricular septum, which is located very near the auriculoventricular bundle, existed in almost all of these cases. In the writers' case, in a girl of 9 months, the symptoms were perspiration, irritability and cyanosis on crying. There was frequent arrhythmia and change of pace, with a loud systolic murmur. Electrocardiography showed a complete heart block with auricular rate, 160, and ventricular, 70. A month later she was generally improved, though the block persisted. E. C. Romberg and P. D. White (Boston Med. and Surg. Jour., Apr. 3, 1924).

Combinations of heart block with other arrhythmias referred to. Case of block in a woman of 60 with interstitial nephritis, in which there were periods of auricular flutter passing into auricular fibrillation, these periods of rapid auricular beat being accompanied by absence of the radial pulse, too brief to cause unconsciousness. Sudden slowing of the pulse to 30 or 40 sometimes followed 2 minutes of rapid pulse rate. S. de Boer (Nederl. Tijds. v. Gen., Feb. 9, 1924).

**Prognosis.**—This is largely dependent upon the heart affection, of which heart block may be but one feature. Heart block due to an actual lesion of the conduction tissue usually is permanent, especially if it has already persisted for more than a few weeks. In certain acute diseases much improvement may occur spontaneously with convalescence from the acute condition, which is generally an infection. Heart block of organic cause is always a serious condition; sudden death is not uncommon, many cases surviving but two or three years when the block persists. There are

instances, however, in which the patient has lived in comparative comfort for years. Transient heart block due to vagus stimulation or to the effect of digitalis is, of course, in a different category.

In a boy, aged 7, bradycardia had attracted attention; there was total heart block. At 20 he had gone through several infectious diseases, but the general condition remained constantly good. The prognosis in this case does not seem to be grave, as there is no progressive tendency, and the heart seems able to cope with any strain, as shown by tests with graduated exercise. E. Zander (*Hygiea*, Sept. 15, 1925).

**Treatment.**—The treatment is primarily that of the underlying disease. Patients who are between thirty and sixty years of age should be subjected to the therapeutic test for syphilis when heart block is present. Luetic heart involvement tends to progress, and the aim should be to prevent further impairment of the integrity of the heart.

**Arsphenamin** or **neoarsphenamin** is used in cases of luetic origin when the myocardium is not too seriously damaged. **Mercury** is given during the intervals. The **iodides** have also been exhibited in massive doses with good effects, and are used with advantage when arsphenamin is contraindicated. In the so-called functional form, in which the heart muscle and valves are functionally efficient, **atropine** is employed; it often causes the block to disappear. J. M. Anders (*Med. Rec.*, Sept. 25, 1920).

Heart block due to poisons will disappear with the removal of the cause.

When it seems likely that block may be induced by vagal influence, **atropine sulphate** in doses of  $\frac{1}{120}$  to  $\frac{1}{100}$  grain (0.0005 to 0.00065 Gm.) 3

or 4 times daily will release vagal control of the heart and thus furnish valuable clinical data.

Even a mild attack of unconsciousness calls for a period of absolute rest in bed. A single injection of **atropine sulphate**,  $\frac{1}{60}$  grain (0.0013 Gm.), may be tried. To prolong the effect,  $\frac{1}{100}$  grain (0.00065 Gm.) may be given by mouth to physiological effect. Heart stimulants such as digitalis and strophanthin are mostly contraindicated. J. E. Talley (*Med. Rec.*, Nov. 27, 1920).

In experiments on men and dogs injected intravenously with **atropine**, the writer was led to conclude that dromotropic action of this drug on atrio-ventricular conductivity, during the stimulation phase, is due to its sympathicotropic action. Besides, it exerts a direct effect on the bundle of His. In 2 cases with block, no improvement of conduction was obtained with 1 mgm. of adrenalin, while a marked influence was manifest with small doses of atropine. Meyer (*C. r. Soc. de biol.*, Aug. 14, 1925).

The presence of complete heart block is no contraindication to the use of digitalis when that drug is indicated by a progressively failing heart muscle; but the block must be complete.

The heart's action became accelerated at once after intravenous injection of **adrenalin** in 2 cases of complete heart block; the block itself, however, was not modified. After the acceleration, the beat was extremely retarded for several days. The accelerated ventricle beat was often interrupted by long pauses followed by syncope. He emphasizes the danger of the use of adrenalin. Lutembacher (*Arch. des mal. du cœur*, Aug., 1920).

In branch bundle block **digitalis** is not contraindicated. The writer has given it with good effects and no harmful consequences in several cases. O. V. C. E. Petersen (*Hospitaltid.*, Sept. 20, 1922).

There is clinical evidence that **adrenalin** subcutaneously in *partial heart-block* may restore conduction to normal; in 2:1 block, either the mechanism may be restored to normal or dissociation may follow. In *complete block*, normal sequence may result or else, usually, an acceleration of the auricles and ventricles. Frequently recurring *Stokes-Adams attacks* may be abolished. The dose is 0.3 to 0.6 c.c. (5 to 10 minims) of the 1:1000 solution, and the effect lasts about 12 hours. In patients with a considerable degree of arteriosclerosis or with hypertension (and in many complete blocks there is high systolic pressure), the risk from adrenalin must be weighed against the risk and discomfort of the syncopal attacks. II. Feil (Jour. Amer. Med. Assoc., Jan. 6, 1923).

In a case of a man aged 44, there was apparently an acute lesion in the myocardium involving the bundle, with a period of complete dissociation followed by gradual recovery of conduction. Adams-Stokes attacks occurred throughout. In 12 attacks, with 1 doubtful exception, **adrenalin** abolished the attack in 3 minutes. In complete block the ventricular rate was raised to 60, the block persisting; in partial block, both the auricular and ventricular rates rose to 120 and normal sequence was restored. A dosage of 5 to 10 minims subcutaneously is advised. J. Parkinson and C. W. Bain (Lancet, Aug. 16, 1924).

**Resection of the vagus** performed with success in a case of Adams-Stokes syndrome in a woman of 28. The disorder had followed a tonsillar operation, and each attack was combined with severe pain on the outside of the ear and dysphagia, suggesting a vagus neurosis restricted to the cardiac branches. The Adams-Stokes symptoms ceased after the operation; recurrent laryngeal paralysis was, however, produced. H. von Hoesslin and R. Klapp (Klin. Woch., July 1, 1924).

**PULSUS ALTERNANS.**—An alternating pulse, or pulsus alternans, can

hardly be diagnosed save by instrumental means. It is best demonstrated by the polygraph, although some observers believe that it can be recognized at times in the electrocardiogram. Alternation may be clinically detected when estimating the blood-pressure; it will be noted that as the maximal air pressure is released, the pulse suddenly doubles in rate. A bigeminal pulse may be confused with pulsus alternans.

Electrocardiograms do not always show a true pulsus alternans, but sometimes a *pseudo* pulsus alternans. The variations in pressure due to the respiratory phase have not been taken sufficiently into consideration. One cannot always draw conclusions as to the condition of the myocardium from tracings, as it may be irritable without being diseased. Paul White (Med. Rec., June 18, 1921).

The most delicate diagnostic procedure is the auscultatory blood-pressure method, which reveals not only the alternation of systolic pressures of the strong and weak beats, but also the alternation of their diastolic pressures. The diastolic pressure of the strong beat is always lower than that of the weaker beat, a greater pulse pressure resulting. The prognosis of permanent alternation, present in 5 of the writer's 14 cases, is graver than that of transient alternation. Accompanying conditions comprised cardiac enlargement in 13 cases; arteriosclerosis, 13; hypertension, 12; dilated aorta, 9; renal disease, 9; angina pectoris, 2. In 9 cases the pulse was regular—a reason why pulsus alternans is frequently overlooked. R. Lyons (New Orl. Med. and Surg. Jour., Oct., 1923).

The exact nature of the defect causing alternation is not definitely known. The condition is generally ascribed to a variation in contractility of different areas of the ventricular muscle. The ventricular action is



regular, but there is an alternation in the amount of blood expelled into the aorta. Alternation must alternate; there is no such thing as alternation every third or fourth beat.

An experimental study of pulsus alternans led to the conclusion that this condition is produced by a disturbance of the metabolic equilibrium of the ventricular muscle. This can be produced by poisons such as digitalis, barium chloride, etc., which are capable of inducing increased activity of the ventricular muscle. S. de Boer (Pflüger's Archiv f. d. ges. Physiol., Nov. 12, 1921).

Pulsus alternans, in very rare cases, may be found in an otherwise healthy heart that has been overtaxed and is beating at a rapid rate. But it is almost invariably detected in hearts seriously involved by chronic heart-muscle degeneration. Alternation is particularly common in association with the changes in hypertensive heart involvement and in the arteriosclerotic heart, in which it may be attended with angina pectoris.

In 24 of 25 cases of pulsus alternans there was uremia. Chalker and Contamin also found uremia in 7 of their 10 cases. The pulse was normal in 2 cases of extreme uremia with acute nephritis, and in 1 with jaundice. The pulsus alternans may be intermittent in uremia, or may escape detection. It seems to be due to both the hypertension and the uremic poisoning. J. Heitz (Prog. méd., Feb. 12, 1921).

The detection of pulsus alternans is important chiefly from its bearing on the prognosis. The majority of patients who exhibit the phenomenon succumb within a few months.

The gravity of the condition varies according to the amount of pressure in the arm-cuff required to elicit the alternation. Where there is required a pressure approximating the patient's systolic pressure, the disturbance is

incomplete and the patient may live much longer. If only a pressure approximating the diastolic pressure is required, survival rarely exceeds a few months to a year. Alternation is elicited by constantly diminishing pressures in the unfavorable cases. It is ascribed to lack of participation of a portion of the muscle fibers, impaired by myocarditis, in some of the contractions. Regnier (Arch. des mal. du cœur, Sept., 1924).

Low blood-pressure is prognostically unfavorable in pulsus alternans. A. Navarro (Sem. méd., Sept. 18, 1924).

Treatment should be directed to the underlying heart condition.

In pulsus alternans associated with physical overwork, increase of **bodily rest** is demanded, while cases due principally to mental overtaxation call for a **lessening** of the **stress of mind**. In the class of cases with simple paroxysmal tachycardia, cautious use of **digitalis** is sometimes serviceable, but in the more serious form seen in elderly subjects with a heart rate not above the normal limits, this drug is not advised, safety here demanding reliance upon **rest**. J. M. Anders (Med. Rec., Sept. 25, 1920).

In 24 cases a **low protein diet** often reduced or banished the alternans in a few days. The discovery of the slightest tendency to pulsus alternans in a case of heart and kidney disease calls for immediate suppression of nitrogen in the diet, to be kept up until the alternation has disappeared. Heitz (Prog. méd., Feb. 12, 1921).

Combination of premature contractions with pulsus alternans tends to exaggerate and perpetuate the alternation. In the writer's case, the added ventricular extrasystoles were revealed by electrocardiography. While such a combination portends grave myocardial disturbance, gradual improvement in their patient took place under **digitalin**, **ouabain** and **theobromine**; **antisiphilitic medication** added further benefit. A. Clerc and G. Perrochaud (Bull. Soc. méd. des hôp. de Paris, July 19, 1923).

The treatment consists mainly of prolonged, complete rest in bed, a low salt and low nitrogen diet, digitalis and, whenever feasible, the removal of infections and toxemias. R. Lyons (New Orl. Med. and Surg. Jour., Oct., 1923).

## MYOCARDITIS.

**DEFINITION.**—Myocarditis is a condition characterized by inflammation of the heart muscle.

It is of two principal types, *acute* and *chronic*, although there is no exact line of demarkation between the two.

### I. ACUTE MYOCARDITIS.— SYMPTOMS AND DIAGNOSIS.

—The symptoms and signs of acute myocarditis are varied and often difficult to ascertain. The ordinary subjective evidences are precordial pain, at times simulating angina, palpitation and dyspnea. The electrocardiogram, however, frequently gives warning of myocardial invasion long before clinical signs appear. A study of the pulse rate and rhythm is clinically helpful. The condition is ordinarily associated with fever, which alone induces rapid rate. In many cases the heart rate is out of proportion to the fever.

Irregularities or pulse intermissions are indicative of direct myocardial invasion, as they are usually the result of damage to the atrio-ventricular bundle. The alternating pulse is often associated with myocardial invasion in the acute forms.

The most significant evidence of myocardial invasion is an irregularity of the heart beat, such as premature beats, paroxysmal auricular fibrillation, or paroxysmal tachycardia. Partial heart block, particularly frequent in rheumatic fever and diphtheria, can usually be recognized only in the graphic tracing by noting the prolonged auriculoventricular interval.

Occasionally a dropped beat may be noted on auscultation. In addition, the patient usually presents signs of general infection, such as fever, prostration and leucocytosis.

The diagnosis of myocarditis is warranted only in the presence of one of the infections known to affect the heart muscle, and when there are localizing signs such as cardiac dilatation or arrhythmia. Tachycardia, breathlessness, precordial pain, weak heart sounds and low blood-pressure are of little diagnostic value in this connection, being frequently caused by the vasomotor disturbances which often follow acute infectious disease.

In the cases in which myocarditis is fulminating, as in diphtheria or, at times, in the rare cases of interstitial myocarditis, the patient may experience sudden extreme prostration or collapse, with vomiting. More often there are no definite localizing symptoms. An accompanying pericarditis or endocarditis may help in drawing attention to the heart. The congestive signs of heart failure, such as edema and hepatic enlargement, are not conspicuous in most cases of acute myocarditis. E. P. Boas (Med. Jour. and Rec., Mar. 19, 1924).

Very frequently the condition remains latent at first and is recognized only upon the advent of the subjective signs. Replacement of the precordial impulse by a short undulating movement may be observed. Characteristic signs consist in changes in the sounds and in the rhythm of the heart. A weakening of the first sound is important and occurs first at the base. Later, alteration of the second sound develops, more often at the apex. Galloping rhythm or murmurs may appear at the same time. Falling arterial pressure goes hand in hand with weakened heart sounds; it may fall as much as 60 or 70 millimeters of mercury; when the pressure remains at this level the pro-

gnosis should be considered to be particularly serious.

The association of weakening heart sounds, lowering of the blood-pressure, fetal rhythm and tachycardia very often constitute the terminal syndrome of myocarditis. Arrhythmia tachycardia is often a forerunner of death.

**ETIOLOGY.**—Acute myocarditis is due to a bacterial infection or an intoxication. Almost any infectious disease may cause it. The septicemias and all the streptococcic infections are often complicated by myocarditis. *Streptococcus viridans* is a prominent etiologic factor. As is well known, too, the Klebs-Löffler bacillus frequently induces heart muscle change during or after diphtheria. Influenza has become an increasingly common cause of acute or subacute myocarditis; in the subacute cases the myocardial damage is generally not revealed for a considerable interval after the infection. Typhoid fever, pneumonia, scarlet fever and measles are relatively frequent sources of acute myocarditis.

Among other recognized causes are smallpox, cerebrospinal meningitis, malaria, and rarely, tonsillitis. Included in the septic group, aside from rheumatic fever, are the cases secondary to malignant endocarditis, puerperal sepsis, osteomyelitis, erysipelas and gonorrhea.

**PATHOLOGY.**—Three forms of acute myocarditis have been described: Acute parenchymatous, acute interstitial and acute suppurative myocarditis.

At the autopsy table, a heart the seat of acute myocarditis presents macroscopic changes in color and consistency. The walls may be hy-

pertrophied or thinner than normal. The organ is usually soft and flabby, and is easily torn and friable.

The *parenchymatous* variety is most constant and earliest in appearance. It is due to the action of bacteria and toxins on the fibers, which are striated and become homogeneous. They may have a barrel-like appearance, due to liquefaction. Granular and granulo-pigmentary degeneration supervenes, and likewise fatty and hyaline degeneration. Such lesions are rarely isolated.

The *interstitial* variety of myocarditis affects chiefly the superficial subpericardial portions of the heart muscle, particularly at the base and apex. The fundamental change consists in a round cell infiltration surrounding the small arterial twigs and extending between the muscle fibers to separate and disorganize them and even penetrate into their interior.

*Suppurative* myocarditis is very unusual and has no definite relation to the preceding forms. It is probably due to a specific pathologic organism and usually occurs in the form of one or more abscesses, perhaps the size of a hazel nut, which may be looked for in the wall of the left ventricle and in the upper part of the interventricular septum. The pus may be discharged into the ventricle, and the cavity thus left in the muscle fills with blood, forming a cardiac aneurism; discharge of the pus gives rise to septic emboli and a true blood infection. This type coincides with the ulcerative forms of malignant endocarditis. In the other forms the pus is not concentrated in a single abscess, but if abscesses do exist they are minute and disseminated throughout the thickness of the

myocardium. Such conditions frequently are found in the left ventricular wall, where they begin in the interstitial tissue and are followed by destruction of the muscle fibers or fatty granular degeneration.

It is a question whether there actually are two such types of acute myocarditis as the interstitial and parenchymatous. One school teaches that the parenchymatous lesions are primary and that these lesions, irritative and degenerative in nature, are followed by inflammatory reaction in the connective tissue cells. Others maintain that the interstitial lesions are primary and of inflammatory nature, the lesions of the muscle fibers being secondary and degenerative. A choice between these 2 opinions is, perhaps, difficult, though there is a tendency to give precedence to the parenchymatous lesions. The conception of an acute primary interstitial myocarditis cannot be rejected, as the rheumatic type of myocarditis usually appears in this form.

The essential lesion of the heart in *diphtheria* is a toxic parenchymatous hyaline degeneration or necrosis, associated frequently with fatty degenerative infiltration and less frequently with cloudy swelling or a simple necrosis. The latter lesions are most probably due to accompanying nutritional conditions. Following the lesion, either a complete regeneration or a fibrosis may result. The toxin may damage the conducting mechanism as well as the contractile; no special affinity is shown pathologically for either apparatus. In 16 patients who died from cardiac failure, disturbances in rate, rhythm and heart sounds had been present in all, with a general picture of dilatation. No endocarditis was found in any of the cases. In 1 only was there a mural thrombus. Nine presented well marked

features of the thymicolymphatic constitution. In 9 there was a more or less pronounced bronchopneumonia. Hyaline degeneration or necrosis was the 1 constant parenchymatous cardiac lesion. In the early deaths this may be the only histologic lesion in the myocardium. A. S. Warthin (Jour. of Infect. Dis., July, 1924).

Case of a man aged 41, who died on the 16th day after the onset of acute heart disease. The condition was a primary diffuse interstitial myocarditis, the myocardium being infiltrated with lymphocytes. The liver showed some alcoholic cirrhosis. Mordre (Norsk Mag. f. Lægevid., Sept., 1924).

**TREATMENT.**—The first indication is to prevent the myocarditis, if possible, by energetic treatment of the underlying condition which may evolve into it. Large doses of **salicylates** should be administered at the outset of rheumatic fever. They should not be discontinued on the appearance of cardiac symptoms; it suffices to reduce the dose to 40 to 50 grains (2.5 to 3.35 Gm.) a day.

In diseases associated with hyperpyrexia every available means should be adopted to moderate the fever. In typhoid fever **cold baths** should be employed and should be continued, even if heart failure seems imminent, although under such circumstances they may be given at a slightly higher temperature, with **cold applications to the head**. Only actual collapse should cause their discontinuance. The patient should, of course, be substantially fed, lack of nourishment being an occasional cause of weakness of the heart.

In actual collapse recourse must be had to drugs of rapid and energetic action. The injection of **camphorated oil**, 30 to 45 minims (2 to 3 c.c.) of a 10 per cent. solution every three or

four hours during the dangerous period, is an old remedy. Recent observations have discredited it somewhat, the claim being made that it is without any action whatever. Injections of **sparteine**,  $1\frac{1}{2}$  grains (0.1 Gm.) daily, are sometimes useful. Injections of **physiological salt solution** and **glucose solution** may be of value. **Caffeine** intravenously is a life-saving measure at times, and the beneficial results more than counterbalance such possible undesirable effects as insomnia, nervousness, etc.

The dependable cardiovascular drugs are **digitalis**, **adrenalin**, **strophanthin** and their substitutes. In early cases of myocarditis **digitalis** is indicated, and its timely and judicious administration frequently prevents collapse. It should be used without hesitation when the pulse is accelerated and arrhythmic, preferably in small doses of from 12 to 15 minims (0.75 to 1 c.c.) of the tincture daily or 3 times a day until the cardiac symptoms have abated.

There is a form of infectious myocarditis with a rather abrupt onset of manifestations of cardiac insufficiency, occurring in otherwise healthy individuals of any age. Special features are a more or less pronounced anemia, leucocytosis, and fever. On auscultation a peculiar vibration of the whole heart at each beat is elicited, and a heaving of the heart may be felt on palpation. Various arrhythmias may coexist. Many of the cases occur independently of rheumatism, and the cause probably varies. Death frequently takes place, after alternating periods of improvement and exacerbation. The condition is rather unresponsive to heart tonics. **Digitalis** or **strophanthus** may, however, be used, but quinidine should not be given for the arrhythmia, as it may prove fatal. If antisyphilitic treatment seems indi-

cated, caution is required in the use of **arsphenamin** and even of **mercury cyanide**. The only really serviceable drug appeared to be **methenamine**, daily intravenous injections of 0.25 to 0.5 Gm. (4 to  $7\frac{1}{2}$  grains) being given for long periods. A **salt-free vegetarian diet** is advocated. Lautier (*Arch. des mal. du cœur*, Oct., 1922).

In the myocarditis of severe infections, combined with loss of tone of the abdominal vessels and a sudden drop in blood-pressure, the writers advise the use of the crystalline digitalis-like principles, such as **digotin**, intravenously or intramuscularly. **Adrenalin** is of value particularly when the diastolic pressure falls, and may be given hypodermically to the initial amount of 0.2 c.c. (3 minims) of a fresh 1:1000 solution every hour or oftener or slowly injected intravenously, 0.1 c.c. ( $1\frac{1}{2}$  minims) in 10 c.c. ( $2\frac{1}{2}$  drams) of saline solution. Ehrmann and Dinkin (*Deut. med. Woch.*, Dec. 15, 1922).

**Adrenalin** and **suprarenal extracts** have been recommended in infectious diseases complicated by myocarditis. These are given on the theory that the cardiac collapse is due to a suprarenal insufficiency. The action of adrenalin usually is manifest in from 10 to 15 minutes after the injection and lasts for about 4 hours. Its action is signalled by an acceleration of the pulse and a rise in blood-pressure. The dose for injection usually is  $\frac{1}{60}$  to  $\frac{1}{20}$  grain (0.001 to 0.003 Gm.) for children of three to six years, and  $\frac{1}{30}$  to  $\frac{1}{10}$  (0.002 to 0.006 Gm.) for older children. If the suprarenal extract is used, the dose is 1 to  $1\frac{1}{2}$  grains (0.06 to 0.1 Gm.) daily.

**Pituitary extract** has been recommended in injections of  $1\frac{1}{2}$  to 7 grains (0.1 to 0.45 Gm.) repeated 3 or 4 times in 24 hours. This medication is suitable when it is desired to

obtain a slower, somewhat sustained effect, adrenalin being, on the other hand, employed when a rapid and energetic action is required.

**Strophanthin** answers the same indication. It is used in doses of  $\frac{1}{120}$  to  $\frac{1}{60}$  grain (0.0005 to 0.001 Gm.) by intravenous injection. **Ouabain** is sometimes substituted for strophanthin on the theory that it is safer. It also is given intravenously, the first dose being  $\frac{1}{240}$  grain (0.00025 Gm.); a second similar dose is given 12 hours later, and the drug then repeated every 24 hours for 3 or 4 days.

The general treatment must not be neglected and is as important as the drug treatment. **Rest in bed** is the rule in all cases in which fever or sufficient other evidence indicates the presence of an active infection of the heart. Rest should be absolute or nearly so. **Massage** and **passive motion** are worth employing in early convalescence from serious heart failure, as they tend to increase the patient's comfort and to preserve muscle tone.

The mental and psychic attitude of the patient should not be neglected. The depressing word "heart disease" should not be used in the patient's hearing. Coöperation of the patient is essential and it is necessary to give him some knowledge of his problem. This should be stated in simple language that will be easily understood. Environment requires consideration and unfavorable influences should be removed as far as possible.

In the **diet** simplicity, variety and moderation are to be desired. Obese patients should reduce weight. When edema is present, **restriction of fluid** to 800 to 1000 c.c. daily may be desirable in some cases. The bowels

should receive attention; straining is undesirable. Prolonged hot baths should be avoided, **baths** of medium temperature being permissible.

## II. CHRONIC MYOCARDITIS.

—Under this heading are grouped a certain number of diseases of the heart, characterized anatomically by a combination of sclerosis and hypertrophic dilatation of the myocardium, and clinically by various symptoms, of which the most constant are dyspnea, cardiac irregularities and attacks of acute or gradual failure of the heart.

### SYMPTOMS AND DIAGNOSIS.—

The clinical picture of chronic myocarditis is quite obscure. It may be marked by the symptoms of the associated arterial or visceral lesions, or it may not differ in any way from heart failure due to any other cause. Its onset is insidious, the condition slowly evolving until symptoms appear which result from a diminution of functional activity of the heart. Before that time there are only general symptoms, such as palpitation, precordial distress, etc., while in those cases associated with hypertension the symptoms of aortitis, arteriosclerosis, interstitial nephritis, angina pectoris, etc., dominate the picture. It is only through an error in diet or effort, or through an intercurrent illness, that the failure of the heart manifests itself by cardiac symptoms.

Gastric and abdominal symptoms in chronic myocarditis emphasized. The writer saw 14 cases in which they were the initial complaint. In 8 instances they were accompanied at times by severe pain. Some patients complained of fullness in the abdomen; they loosened their clothing after eating, and escape of gas through the

rectum gave relief. Five had a blood pressure much below normal and in 3 it was slightly raised. Ten had arrhythmias. Six died, all suddenly. In the treatment, he **restricts the proteins and starches** in the cases with paroxysmal pain, allowing the others, however, usually a liberal protein diet. The pain is generally relieved by **nitrites**, but in the other group of cases the abdominal symptoms are usually made worse by them. The cases without pain are more benefited by **digitalis**. R. K. Barry (Cal. State Jour. of Med., Oct., 1922).

Chronic myocarditis when fully developed is characterized by a group of functional and physical signs, chief of which are dyspnea, cardiac enlargement, disorders of rhythm, atypical murmurs and varying degrees of heart failure.

An irregularity of the pulse is a symptom to be expected in chronic myocarditis. It is either of the extrasystolic type or a complete arrhythmia. The pulse may be slow, indicating involvement of the atrio-ventricular bundle, while at other times the pulse may alternate, this being a sign of serious prognostic import.

The apex of the heart is usually displaced downwards and outwards beyond the nipple line. The precordial impulse may be more forceful and of greater extent than in the normal heart, while on the other hand it may be almost imperceptible on account of being obscured by a covering of emphysematous lung or because the myocardium is insufficient. The width of the heart is increased in the transverse diameter, both on percussion and on X-ray examination. This transverse increase in diameter indicates enlargement of the cavities on the right; when the vertical dia-

meter is increased the cavities on the left are involved.

A diagnosis of myocarditis is sometimes made merely on the basis of a rapid heart rate. As a matter of fact a rapid heart is as common in *effort syndrome* as in heart disease at the time of examination. Again, premature beats or a pronounced sinus arrhythmia of the respiratory type at times lead to the diagnosis of myocarditis. The former are no more common in heart disease than in its absence, while sinus arrhythmia is commoner in effort syndrome than in heart disease. The important presumptive indications of heart disease are diastolic murmurs, cardiac enlargement, and rheumatic history. Absence of these indications, and the presence of certain nervous symptoms such as tremor, lively knee-jerk, and "nervousness," are presumptive evidence of effort syndrome. More than  $\frac{1}{2}$  of the latter cases have at least 2 of the 3 "cardiac" subjective symptoms: Heart pain, palpitation, and shortness of breath. To be sure, a patient may have both heart disease and effort syndrome. McCrudden and White (Boston Med. and Surg. Jour., Feb. 8, 1923).

The heart sounds are muffled, especially the first sound, and frequently a galloping rhythm is present, similar to that observed in chronic interstitial nephritis. The association of gallop rhythm with extrasystolic irregularities and the dyspnea attendant upon effort constitute a syndrome that portends heart failure. Murmurs, if present, may be due to functional inefficiency of the valves or they may be due to chronic lesions. Functional murmurs of the mitral valve appear early and are soft, variable, and likely to disappear under rest and appropriate medication. For this reason they are often considered as being of extracardiac origin.

Functional tricuspid murmurs do not appear until an advanced stage.

Chronic myocarditis is frequently diagnosed as mitral stenosis. The latter is really rare unless combined with insufficiency of the same valve, and this combination rarely develops after 40, when myocarditis is most common. The chief symptoms of chronic myocarditis are breathlessness, rapid pulse and precordial distress occurring spontaneously or on very slight exertion; usually these are accompanied by enlargement of the heart and a mitral systolic murmur. Christian (*So. Med. Jour.*, Aug., 1921).

Graphic methods are indispensable in investigation of the heart in chronic myocarditis.

Electrocardiography often yields evidence of unsuspected heart conditions in those seeking life insurance at the average age of about 30 years—conditions which, continuing to the age of perhaps 45, would so progress as to become manifest in physical signs of heart fault. On the other hand, it also reveals the benign nature of certain irregularities, sometimes accompanied by suspicious auscultatory phenomena. The more severe focal infections and toxic factors, such as infective tonsils and poisonous liquor, may produce symptoms of heart muscle inefficiency to a degree simulating structural heart disease, with the physical signs of heart enlargement and abnormal sounds. On removal of these causes, the symptoms abate, the physical signs disappear, and the heart is amply sufficient indefinitely. S. Calvin Smith (*Jour. Amer. Med. Assoc.*, Apr. 7, 1923).

On examining the patient elsewhere, signs are found that arise from heart failure rather than from myocardial sclerosis, such as painful congestion of the liver, transient peripheral edema, subcrepitant râles at the base of the lungs which disappear under the influence of rest, etc.

The urine is abundant and of low specific gravity when the myocarditis coincides with renal sclerosis, diminishing in proportion as the cardiac efficiency fails.

Characteristic of the condition is the tendency to heart failure with dyspnea. This may manifest itself in an acute form or in recurrences. Failure of the heart may appear at the outset. Following exertion or an indiscretion in diet, the patient may be suddenly seized with intense dyspnea accompanied by fine subcrepitant râles throughout the extent of both lungs, with bloody expectoration. Or the onset may be an attack of angina pectoris. Either form of onset is caused by sudden enlargement of the cavities of the heart. Death may occur at this time, or there may be longer or shorter remissions.

Often the heart dilates and the syndrome of acute heart failure follows; peripheral edema increases, the liver enlarges and is painful, the jugular veins engorge, and congestion invades the entire chest.

These symptoms appear more frequently in those patients suffering from arterial hypertension, renal sclerosis or chronic aortitis, and may subside, leaving the patient in a state of unstable equilibrium. The symptoms will recur at the least provocation, until finally the myocardium becomes wholly inefficient.

Attention called to the feasibility of determining by fluoroscopy a poor quality of heart-muscle, the writer meaning by "poor quality" an inefficient heart in its broadest interpretation, including the clinical term myocarditis. The roentgenologist may recognize potential heart disease before either the physician or patient is aware of it. For such examinations



the patient is best placed in the right posterior position, and should be rotated to the angle most favorable for bringing into view the entire border of the left ventricle. The study is to be based on the pulsatory waves of the heart, and there are to be considered their amplitude, the completeness of each contraction, whether the waves are limited to certain areas only, absence of waves from the normal area, and a comparison of ventricular action with auricular action. Small, healthy hearts pulsate more vigorously and thoroughly than normal-sized or slightly large hearts; if a small heart contracts sluggishly or with a pulsatory wave of diminished visibility, its musculature is probably not up to standard. Enlargement is one of the most reliable signs of poor quality heart muscle. If to large size there is added very little visible motion, evidence exists that the greater part of the heart is composed of poor quality muscle. H. Spiro (Radiol., Dec., 1923).

As a general rule, however, the failure of the heart is gradually progressive, and is preceded by a variable period of dizziness on effort, at first intermittent, with substernal constriction and by attacks of nocturnal asthma. Then, after several months, there develops continuous oppression, which is falsely attributed to an ordinary bronchitis or to emphysema. The appearance of edema of the extremities, painful congestion of the liver, diminution of urinary output, and disorders of the cardiac mechanism all announce the fact that cardiac failure is imminent. The heart increases in size and shows but little improvement under customary medication. Later, the hepatic congestion becomes complicated by cirrhosis, the edema reaches the abdominal walls and the ascites increases.

Disorders of cerebral circulation are not uncommon. They are characterized by a subcomatose state with respiratory irregularities of the Cheyne-Stokes type. This has been observed to coincide with redness and dryness of the tongue, with thirst, with an acetone odor to the breath, and with contraction of the pupils. This toxic state is connected with heart failure only to a moderate degree and indirectly; it is attributed to a form of acid intoxication.

The heart is affected in  $\frac{1}{3}$  of all primary and secondary cases of syphilis. There are 2 forms of *early syphilitic myocarditis*. In the first, toxic substances produce great excitability of the myocardium, followed by exhaustion, as manifested by prolonged bradycardia or tachycardia. In the second form, interstitial degeneration of the muscle is followed by sclerosis, both of the myocardium and of various blood-vessels. The effects vary according to the extent of the functional disturbance or organic changes present. Both forms are curable. In a woman of 24, syphilitic for only 2 months, the pulse rate was 114, the pulse small and hardly perceptible, and the apex beat very faint. Palpitation was present, but no murmur. Cure was obtained with mercury and *arsphenamin*. To avoid incurable cardiac lesions, early treatment is exceedingly important. Of all syphilitic cardiac affections early myocarditis is the most common. Some cases produce no symptoms. The Wassermann is of great value in diagnosis. E. M. Villapadierna (Siglo méd., May 19, 1923).

**ETIOLOGY.**—Chronic myocardial change may follow acute infections in which the heart muscle has been involved. In many instances, however, its cause is some persistently acting infection or toxic agent which induces gradual changes in the

muscle tissue. Thus, among the chemical poisons, lead, arsenic and mercury may, on prolonged use, produce myocardial change; so may alcohol. Often the causes of myocarditis are likewise those of arteriosclerosis, and among the recognized agencies are syphilis, gout, diabetes mellitus, rheumatism and malaria, together with long-continued stress in the form of severe muscular labor or excessive mental exertion or anxiety. Chronic nephritis is a common cause of both arteriosclerosis and myocarditis.

Two cases of *syphilitic myocarditis* in hereditary syphilis in infants 1½ and 2 months of age. Syphilitic myocarditis is not so rare as is commonly believed. The condition certainly sometimes gives rise to heart lesions which can be diagnosed clinically, but they are often confused with congenital heart lesions. Some of the cases would be amenable to anti-syphilitic treatment. The disorder has some prognostic importance, as it may be the direct cause of death, which is not infrequently sudden in such cases. N. Johannsen (*Acta pædiatr.*, June 16, 1924).

Some cases have been ascribed to foci of infection in the teeth, tonsils or gall-bladder.

Exhausting conditions such as cancer, tuberculosis, dysentery, the anemias and inanition in general are capable of favoring myocardial change, and obesity has long been credited with a like baneful influence. Exophthalmic goiter at times causes myocardial deterioration, doubtless through long-continued tachycardia and stimulation of the heart-muscle by the excess of thyroid secretion.

Chronic myocarditis may also be secondary to extension of the morbid processes of chronic endocarditis

or pericarditis. It has at times been observed to follow trauma of the anterolateral region of the chest.

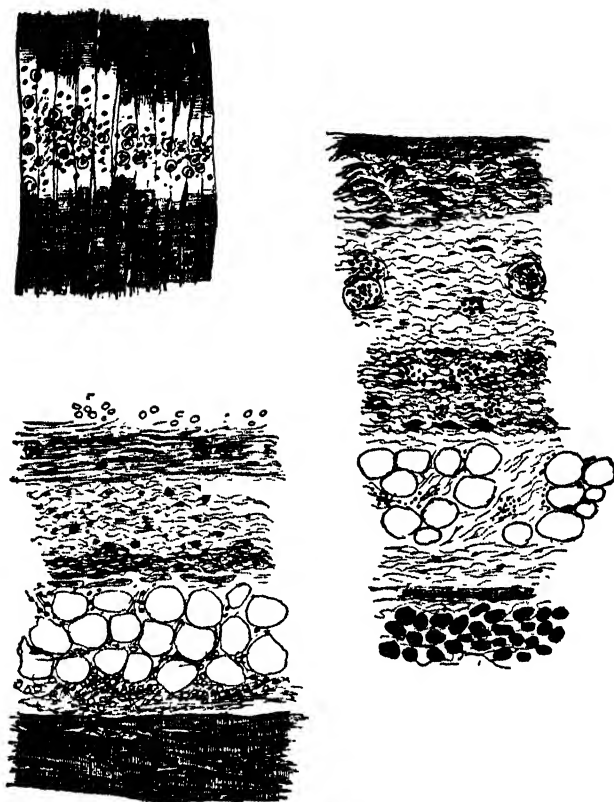
*Hypertension heart* is considered by the author the commonest form of chronic myocarditis. About 15 per cent. of all cases, he asserts, are associated with hypertension or follow in its wake, and the hypertension is the cause of the myocarditis, rather than chronic or acute infection. He quotes Christian to the effect that in 45 per cent. of 400 hospital cases diagnosed as chronic myocarditis, the systolic pressure was 170 mm. or higher. G. E. Fahr (*Jour. Amer. Med. Assoc.*, Apr. 7, 1923).

**PATHOLOGY.**—At necropsy one can expect to find hypertrophy and dilatation of one or both ventricles, chiefly the left. The consistency of the heart muscle is firm, its color is darkened, with white patches here and there, corresponding to the sclerotic areas. These usually are apparent to the naked eye. They are located almost exclusively in the left ventricle, or at least predominate there, and the most pronounced changes are found in the lower half of the anterior surface of the ventricle, the region of the apex or the interventricular septum, and in the papillary muscles of the mitral valve. The auricles are less commonly and less profoundly affected. Sometimes, however, they are the exclusive site of the lesion.

The lesions may be superficial or may involve the entire myocardium, and they may be widespread or localized. When diffuse, they creak when cut through with the knife. The lesions differ in appearance according to their age, the older lesions being white, nearly hard and retracted, the more recent, yellowish, soft and often associated with minute hemorrhages.

The aorta is frequently dilated and atheromatous, the valve cusps encrusted with lime salts and retracted or adherent at their borders, thus causing an insufficiency or stenosis. The coronary arteries may be narrowed by patches of aortitis, the lesions predominating at the coro-

osis, calcification or fibrosis of the wall. If the occlusion be slow, fibrous tissue probably replaces the muscular tissue gradually without the intervention of a stage of necrosis that could be recognized by the naked eye. Two other important events may happen in ischemic necrosis: First, the formation of clot on the inner aspect of the necrosis, which may become detached,



True inflammation of the myocardium. (*W. H. Porter.*)

nary mouths. The trunk and branches of the coronary arteries present chronic arteritis and sometimes thrombotic obliteration. Cardiac infarct may thus be produced, which may end in either rupture of the heart or a series of changes resulting in fibrous cicatricial plaques or a partial aneurism.

Occlusion of the coronary arteries may occur from embolism, thromb-

forming emboli; secondly, the heart wall may be so weakened as to induce rupture. The larger number of cases of ischemic necrosis met with are the result of arteriosclerotic lesions. There is no constancy in the effect of occlusion of various coronary branches. In one case occlusion of the anterior branch of the left coronary produces sudden death, in another angina, in another chronic cardiac failure, in another no symptoms at all. Chronic cardiac failure in old people

in the absence of syphilis, old rheumatic infections of the heart, and pernicious anemia is almost certainly due to ischemic necrosis. A. G. Gibson (Lancet, Dec. 19, 1925).

The endocardium itself presents opalescent sclerous patches, and the fibrous or atheromatous induration of the valves may constrict them. Clots may give rise to emboli. Similar "milky spots" may appear on the pericardium, and the general arterial system is affected at different points by sclerosis and atheroma.

The organic visceral lesions that accompany chronic myocarditis may result from congestion due to failure of the heart, consisting of cyanotic induration of the lungs, liver and kidneys, often with infarction and effusion in serous cavities. Others evolve hand in hand with the heart lesions and, like them, arise from the general process of polyvisceral sclerosis.

Microscopically, changes are revealed which affect the muscle fibers, the connective tissue and the vessels at one and the same time. There are two types, corresponding to the hard and the soft sclerosis seen grossly. The hard sclerosis is manifested in fibroid tissue poor in cellular elements, containing at most a few leucocytes in the lymph spaces at the margin of the sclerotic patch. The fibrous bands follow the direction of the muscle bundles in the affected region. The soft sclerosis differs from the hard variety only by its enormous vascularity.

The hypotheses offered in explanation of the sclerotic lesions of the heart are two; the ischemic hypothesis and the hypothesis of direct action. The ischemic theory maintains that

the sclerosis is the result of slow changes in and obliteration of the vessels, and that there is also a true softening from thrombotic aortitis of a coronary branch. The condition, according to this view, is not an inflammatory lesion but a degenerative one. The hypothesis of direct action maintains, on the other hand, that the cardiac sclerosis is the result of a series of changes in the interstitial connective tissue stroma, independent of sclerosis of the arteries or capillaries.

First recorded case in which calcification of the heart muscle itself, without involvement of the pericardium, was demonstrated by X-ray during life, and confirmed by necropsy. The patient was a Russian, 74 years old, whose roentgenogram showed a fine ring-like shadow, about 3.5 cm. at its widest diameter, occupying the apical portion of the heart. Calcium was found to be deposited in large quantities within the necrosed apical portion; apparently the lesion followed obliteration, gradually becoming complete, of the left coronary artery. Deposition of calcium salts within the heart takes place in dead or markedly deteriorated, but never in healthy, tissue. The process begins with deposition of the fine calcium granules, usually calcium phosphate, within the broken-up heart muscle fibers. These granules may gradually coalesce, forming plaques. Calcification may occur in any pathologic condition which gradually leads to degeneration of cardiac muscle fibers of diffuse or localized type. By X-ray, during life, one may even succeed in differentiating myocardial from pericardial calcification. T. Scholz (Arch. of Int. Med., July, 1924).

**PROGNOSIS.**—The only termination of chronic myocarditis is death. This takes place slowly, following obstruction of the lungs resulting from bronchitis and congestion; or, the end

may come suddenly as a result of consecutive attacks of angina pectoris from coronary arteritis or, perhaps, because of rupture of the heart from infarction, or an attack of acute edema of the lungs.

The evolution of the disease is neither fixed nor regular. Its prognosis is grave when the failure is progressive, being relatively less so when it proceeds intermittently. The acute episodes may be followed by remissions of long duration, provided the rules of hygiene and self-care are adhered to. The strained heart may suddenly recover its energy and approach its normal functioning more nearly than does the heart that dilates little by little. The prognosis is subordinate to the concomitant lesions of the liver, kidneys and, above all, to lesions of the arterial system.

**TREATMENT.**—Treatment is directed to checking the lesion of the myocardium, to sustaining or augmenting its energy and, finally, to combatting heart failure when it appears. Chronic myocarditis is hard to influence when it is a late consequence of acute infectious myocarditis.

One form that lends itself very well to treatment, however, is the syphilitic variety. In any case of failure of the heart of unexplained origin, or when such a pulse abnormality as a permanently slow pulse is present, the possibility of syphilis should be suspected, inquired into and searched for by repeated Wassermann tests. If **specific treatment** is adopted, the physician will probably initiate treatment with doses smaller than those ordinarily employed.

In the treatment of syphilitic heart disease, the writer deems it very important to combat the cardiac insufficiency first, then start with **mercury**, and continue with mild **arsphenamin** treatment unless it is certain that cicatricial lesions are not involved. When there are murmurs and other symptoms, the lesions are usually beyond correction. In a case described, the syphilis had been treated with inunctions alone, and 10 years later aortitis developed, with dyspnea, palpitations and dizziness. The man, aged 41, was given 2.45 Gm. of arsphenamin in the course of 6 months (6 injections). He then developed diarrhea, intractable vomiting, enlargement of the liver and jaundice, with fatal collapse on the 9th day. In another case, a large aneurism developed above the right clavicle in the course of a month, 13 years after papules in the mouth had been noted as the only manifestation of syphilis. Under a single injection of **arsphenamin**, the aneurism began to subside, and entirely disappeared under 2 or 3 more injections. Jacobaeus (Ugeskr. f. Laeg., Mar. 20, 1924).

If it seems likely that the myocardial defect is caused or maintained by an intoxication, such as lead or, more commonly, alcohol, such a **cause** should be **removed**. Rich foods, pork products, heavy meats, etc., should be interdicted.

Hygiene and medical treatment should be enforced to postpone the ultimate appearance of chronic myocarditis and sclerosis of the myocardium. The patient should **avoid** all **exertion** which might favor the occurrence of heart failure. Repeated over-exertion, either physical, mental or emotional, may prove disastrous. Indiscretions in diet should be especially guarded against. **Restriction** of the quantity of food must be specifically insisted upon. Overload-

ing of the stomach at any time, particularly at the evening meal, is likely to bring on a cardiac emergency. **Restriction of salt intake** is desirable, as sufferers from myocardial sclerosis also suffer from renal involvement. **Limiting of fluids** to about 40 ounces (1200 to 1500 c.c.) a day is beneficial, as large amounts may cause an increase in arterial pressure. Useful practices which may be adopted in selected cases include moderate and regular **exercise**, light **massage** and gentle **friction**. Weak **carbonated baths** at intervals are desirable and in some cases may prove of benefit.

Case of an elderly gentleman who had suffered for several years from attacks of vertigo and unconsciousness, almost daily, sometimes hourly, and even at shorter intervals. The frequency of the pulse was from 27 to 31 beats in the minute; only every second contraction of the heart caused pulsation. All the physicians who saw the case diagnosed, quite correctly, a disorder of the myocardium and treated him accordingly, but without success. The enormously distended abdomen of the patient had not at first been taken into consideration. Reduction of its size was followed by cessation of the attacks of vertigo and unconsciousness. In cases of dyspnea caused by heart affection, an **abdominal belt** is of great aid. Rose (N. Y. Med. Jour., May 6, 1911).

Case of a woman aged 66 years, suffering from pronounced circulatory weakness due to myocardial degeneration, in which remarkable benefit was derived from the ingestion of large amounts of **cane sugar**. One ounce morning and evening (later increased to 4 ounces per diem). The pulse became regular, its rate dropped from 110-125 to 88-96 and later to 72-84; the edema and cyanosis disappeared, the patient became alert and active and finally left the hospital entirely free of discomfort. All the

usual cardinals had failed. Sir Robert Simon (Birmingham Med. Rev., May, 1912).

Systemic medication is not particularly efficacious in influencing the course of chronic myocarditis. The **iodides** seem to benefit some patients, probably because they facilitate respiration and make the effort of breathing less tiring. One method of administering them is to give 15 grains (1 Gm.) of **sodium iodide** and 15 grains of **potassium iodide** with meals for 15 or 20 days. If arterial tension is abnormally high, **sodium nitrite** may be added in a dose of  $1\frac{1}{2}$  to  $2\frac{1}{4}$  grains (0.1 to 0.15 Gm.) daily, to be taken at bedtime. Or, the physician may prefer to add  $7\frac{1}{2}$  to 15 grains (0.5 to 1 Gm.) of **potassium nitrate** for its diuretic action.

Other medication is symptomatically administered. **Caffeine sodio-benzoate** is employed for the renal insufficiency, but if it adds to the heart symptoms it can be omitted for a few days, during which **digitalis** may be prescribed.

The treatment consists chiefly of **rest**, **digitalis**, and **diuresis**. The former should be complete and protracted. Digitalis may be well given in the form of pills of the powdered leaves, in sufficient dosage. For diuresis, **theophylline** or **theobromine sodio-salicylate** act well when given 2 days after the digitalis. Vigorous catharsis is to be omitted. The diet should be **simple**, and **fluids moderately restricted**. The treatment should be continued until the patient is free from edema in the legs, over the sacrum, and at the bases of the lungs. Digitalis in small doses may then have to be kept up for many weeks. Christian (So. Med. Jour., Aug., 1921).

The writer, with Vaquez, prefers **strophanthus** to digitalis where stimulation of myocardial contractility rather than effects on the nervous and

conducting mechanism is desired. Intravenous injections of 0.25 to 0.5 milligram ( $\frac{1}{200}$  to  $\frac{1}{130}$  grain) of ouabain are advocated. This measure is, however, contraindicated where there is advanced myocardial degeneration. Lutembacher (*Presse méd.*, Dec. 2, 1922).

Further details in treatment will be found under ACUTE MYOCARDITIS.

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## HEART AND PERICARDIUM, DISEASES OF THE (*Continued*).

### HYPERTROPHY OF THE HEART.

**DEFINITION.**—An increase in the thickness of the walls of the heart which may be general, affecting the entire organ, though more confined to, or predominant in, one side of the heart. The left ventricle is rather more often affected than the right. The amount of muscular tissue in the auricles is scanty even when under the influence of hypertrophic changes.

**VARIETIES.**—*Simple* hypertrophy is associated with a normal size of the cardiac cavities. *Eccentric* hypertrophy implies enlargement of the cavities as well as thickening of their walls. *Concentric* hypertrophy—thickened walls encroaching on the cavities—is seldom, if ever, met with. (It is said to occur as a congenital condition. Its existence in any particular case should not be affirmed until by prolonged soaking in water all *rigor mortis* has softened.)

There is a particular group of hypertension cases, in which there is no notable thickening of the superficial arteries and no renal changes of importance. It is common in men

and comprises, in the author's experience, a rather large proportion of women of middle age. The patients are usually robust, stout to obese, and past 50 years of age. In men syphilis at times plays a part. In a majority of cases there had been mental strain and heavy responsibility.

One-half to two-thirds came complaining of indigestion and bloating after meals. A majority of the remainder noticed shortness of breath on exertion. A few were first troubled with vertigo, with numbness and tingling of the extremities, or with ringing in the ears. The heart in these cases is found enlarged, often far beyond what one would expect from either the symptoms or the physical appearance. These patients pass much larger amounts of urine during the night than in the daytime. The blood-pressure is from 190 to 260 mm. Hg or even more.

The hypertrophy of the heart is not due to valvular disease, though not rarely there is a systolic murmur at the aortic area, indicating, evidently, sclerosis in the arch of the aorta. These cases are particularly prone to anginal attacks.

In the treatment, the first and foremost measure is **rest**, mental rest being more important than physical rest. The **diet** is of importance, but more as to quantity than quality. It may be wise to restrict somewhat the nitrogenous foods. The patient should eat a small evening meal. Both tobacco and alcohol are restricted. The bowels must be kept open. Many get comfort from a pill of **phenolphthalein** and **rhubarb**, or from the well-known **compound licorice powder**. An occasional dose of **calomel** or **blue mass** is useful. A simple hot bath or a short electric cabinet bath may at times benefit.

As for drugs, the nitrites are to be used only to relieve symptoms. Where **nitroglycerin** fails, **sodium nitrite** in doses of from  $\frac{1}{8}$  to 2 or even 3 grains may prove useful. **Erythrol tetranitrate** is a powerful vasodilator in doses of  $\frac{1}{2}$  grain (0.03

Gm.), but often produces a painful fullness in the head. The continued use of the nitrites is of doubtful utility unless the pressure is rising, or there is angina pectoris, or marked dyspnea. In such cases they may be given over a long period in large doses. **Sodium iodide** is given two hours after meals, in water or milk. Many patients who are suffering from dyspnea and even from vertigo do well on small doses of **digitalis**. Either the tincture in from 5- to 10- minim (0.3 to 0.6 c.c.) doses three times a day, or the powdered leaves ( $\frac{1}{4}$  to 1 grain—0.016 to 0.06 Gm.) is given.

**Venesection** is undoubtedly at times useful. It is safe to abstract in these cases up to a pint of blood, and if the pressure instrument is kept on the arm and the pressure controlled, one may take off 20 or 24 ounces. The relief from symptoms is often magical. David Riesman (*Amer. Jour. Med. Sci.*, April, 1913).

An infant, aged 5 weeks, had gastrointestinal disturbance, dyspnea and cyanosis. The thorax was prominent anteriorly and the liver was down to the level of the umbilicus. The baby dying 2 weeks later, the heart was found to be  $2\frac{1}{2}$  inches wide, with marked ventricular hypertrophy. The ductus Botalli and foramen ovale were closed and all the valves competent. There was no apparent cause for this congenital hypertrophy. A. J. Scott, Jr., and A. H. Zeiler (*Amer. Jour. Dis. of Childr.*, Jan., 1926).

**SYMPTOMS.**—It is astonishing how little subjective disturbance may be present, even when the hypertrophy is pronounced. To be sure, the enlargement is an attempt on the part of nature, as we shall see under **ETIOLOGY**, to avert symptoms; yet we wonder how the bulk and strength of the organ can fail, as they often do, to attract its owner's attention. There may be cardiac discomfort, throbbing or heaviness, especially when lying

on the left side, but seldom any pain. Sometimes there are signs of cerebral hyperemia: vertigo, tinnitus aurium, flashes of light, headache, and disturbed sleep. In a general way, it is fair to say that the more prominent the subjective symptoms are in any patient, the more likely it is that he has something more than pure hypertrophy: either a merging of the hypertrophy into dilatation or else some neurotic disturbance.

Objectively, we notice the pulse, the chest wall, the epigastrium, and the heart itself. The pulse is of good strength. It is usually not rapid. Irregularity and intermittence suggest failing compensation; although both may occur when compensation is perfect.

Inspection shows a forcible, extended, and dislocated cardiac impulse. This may be powerful enough to render the thorax of a young subject asymmetrical, so that the lower part of the sternum and the ribs adjoining it on the left bulge forward. If the left ventricle is mainly affected, the apex is lower than normal and displaced to the left; if the right ventricle, the apex is displaced still more to the left, but it is not lowered. Enlargement of the right ventricle is evidenced also by pulsation in the epigastrium and in some cases at the right edge of the sternum. Universal hypertrophy, as seen in some cases of aortic regurgitation, lowers the apex to the seventh or eighth intercostal space and displaces it to the nipple line, while the whole body jars under its powerful efforts like a small tug-boat with a large engine. Upon palpation the apex seems blunter than normal, and its impulse is slow and powerful, contrasting with the rather



spiteful tap of dilatation. Sometimes the action of the auricles can be detected by the lightly apposed hand.

Percussion demonstrates an increased area of dullness, extending a trifle higher than normal, or even up to the second space, but exceeding the normal limits mainly in a lateral direction, one or two finger-breadths to the right of the sternum, and as far as the nipple or the anterior axillary line on the left. Inasmuch as aortic regurgitation is sometimes associated with dilatation of the aorta, we may in this disease get dullness in the second right interspace at the right edge of the sternum.

The first sound at the apex is dull and loud. It has a booming quality, contrasting with the valvular snap of dilatation. A reduplication of the first sound at the apex (gallop rhythm) is ominous of beginning cardiac debility. At the base the first sound is not heard so distinctly as in dilatation, while the second sound is loud and clear, with strong accentuation of that valve (aortic or pulmonary) which corresponds to the obstruction that the hypertrophy is trying to overcome. For instance, in chronic nephritis the aortic second sound is accentuated, and, in rightsided hypertrophy, the pulmonic. In the presence of valvular lesions it need not be said that the murmurs caused by them more or less modify or replace the physiological sounds.

#### **DIFFERENTIAL DIAGNOSIS.—**

Nervous palpitation does not give the sensation of strength in the cardiac impulse, although if long continued it merges into hypertrophy. The sounds are more valvular and have a certain "irritable" character.

Dilatation has a feeble impulse,

coming against the chest with a weak slap. The first sound at the apex has less muscular quality than in health, while in hypertrophy the difference is the other way. In other organs we notice signs of failing compensation. There are dullness and moist râles at the base of the lungs or even hydrothorax. The liver is enlarged. Dependent parts are edematous. The urine is scanty, high colored, with an excess of urates and more or less albumin.

Care must be taken not to mistake a displaced heart for an enlarged one, whether the change in position be due to thoracic tumor, pleural effusion, or pressure through the diaphragm. Again, the retraction of the lung because of chronic phthisis or failure to expand after pleurisy may expose a normal heart in an abnormal way. On the other hand, emphysema may mask actual hypertrophy. In a complicated case under my care a left-sided pneumothorax, limited by adhesions, acted similarly.

The area of dullness in pericardial effusion is triangular, with the base downward. That of a generally hypertrophied heart is ovoid. Moreover, the feeble impulse and distant heart sounds would at once exclude hypertrophy.

It is advisable in every case to establish the cause of the hypertrophy. When this can be done it confirms the diagnosis,—besides having a possible influence upon treatment.

**ETIOLOGY.**—Hypertrophy results from increased demands upon the circulation. An essential condition for its development is a fair degree of cardiac and systemic nutrition. A patient far advanced in phthisis cannot develop hypertrophy, nor will

greatly occluded coronary arteries supply to the myocardium the requisite material for new growth. The causes of hypertrophy are these:—

1. Obstruction to the general circulation, as occasioned by coarctation of the aorta, hypoplasia of that vessel, or compression of it by deformed chest walls or tumors.

Aneurism might be expected to cause hypertrophy, but it seldom does, unless associated with aortic regurgitation. Atheroma of the aorta is set down as productive of hypertrophy. It embarrasses the heart because it increases the friction of the blood-current and diminishes the elasticity of the artery. Conversely, hypertrophy tends to produce atheroma by maintaining a high arterial pressure, so that the two conditions are apt to co-exist. Other things which increase the labors of the left ventricle and enlarge it are arteriosclerosis, acute and chronic nephritis and, slightly, pregnancy.

2. A second class includes conditions obstructing the lesser or pulmonary circulation, viz., tumors, excessive pleural effusion, emphysema, chronic interstitial pneumonia, and some cases of phthisis. According to Orth, some cases of chronic bronchitis exhibit a degree of hypertrophy of the right ventricle not accounted for by the amount of emphysema present.

3. Valvular lesions are sure to cause hypertrophy unless the patient is too feeble, or unless he is overwhelmed by the shock of their sudden development, as, for example, when a cusp of the aortic valves is torn off by violent exertion. More will be said about the valves under PATHOLOGY. Chronic adhesive pericarditis causes hypertrophy, particularly when, besides the obliteration of the pericardial space,

there is adhesion of the outer surface of the pericardium to the pleura. Interstitial myocarditis is another cause.

4. Long-continued and severe muscular exertion—as exemplified in blacksmiths, iron-molders, coal-miners, and longshoremen—may endanger the heart; also prolonged or habitual mental excitement or worry, to some extent.

5. Somewhat allied to the preceding causes are exophthalmic goiter and excess in tea, coffee, tobacco, alcohol, and venery. Sometimes more than one cause operate in a single person.

Experimental abnormalities produced in the heart so as to direct the major stream of circulating blood through certain chambers and their corresponding vessels. Among the methods used was puncture of the septum, diverting blood to the shorter pulmonary circuit. There followed a gradual enlargement limited to that part of the circulatory system through which the deflected blood passes, viz., the left ventricle, right ventricle, pulmonary artery, and left auricle. There was also a demonstrable hypertrophy of both ventricles, presumably because of the increased effort necessary to propel forward an increased volume flow of blood. Just after the production of the defect, the right auricle and aorta became smaller, conforming to the decreased flow of blood through them. As compensation occurred by an increase in total blood volume, they returned to their normal size.

Enlargement of the heart in "idiopathic" hypertrophy, essential hypertension and in some cases of cardio-renal disease may be due to an increase in total blood mass following some interference with the mechanism for its control, consisting, e.g., of a chemical alteration of the blood, a diseased function of the kidneys, or an abnormal stimulation of the organs producing the blood cells. E. Holman and C. S. Beck (*Jour. of Exper. Med.*, Nov., 1925).

**PATHOLOGY.**—The muscular fibers of an hypertrophied heart are increased in size somewhat, but mainly increased in number. Macroscopically, the cut surface is red and firm. The extent of the hypertrophy can be determined by the size of the organ, the thickness of its walls, and its weight. A normal heart should be of about the same bulk as the closed fist of the sub-

prove deceptive as to the existence or not of hypertrophy in cases of eccentric hypertrophy, because the walls may look relatively thin and yet be absolutely hypertrophied. Weighing is a valuable procedure. The normal heart weighs 8 or 9 ounces. In disease the organ may weigh 1 or 1½ pounds, and exceptionally 3 pounds, *i.e.*, as much as the liver!

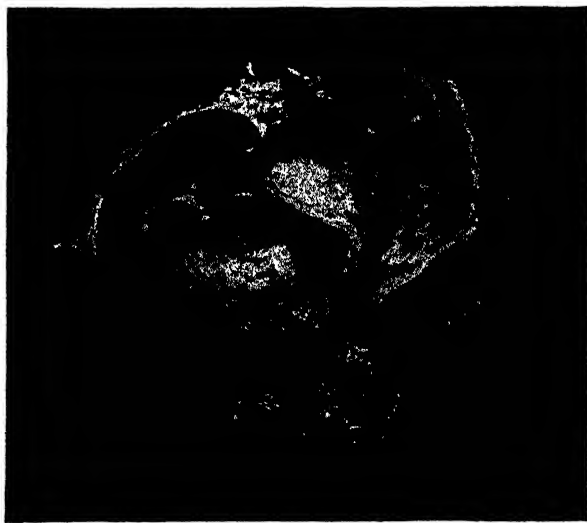


Fig. 1.—Eccentric hypertrophy due to adhesive pericarditis.

ject. The wall of the normal left ventricle is about ½ inch in thickness, and of the right ¼ inch, or a little less. The left ventricle seldom attains the thickness of 1 inch; the right may reach ¾ inch, and it has been reported as being even more than an inch in thickness. The auricles are never very thick. The left in health is about ⅓ inch and may become ¼ inch when hypertrophied. The right auricle is still thinner, and shows its tendency to hypertrophy by changes in its auricular appendix rather than in the rest of its cavity. Before measuring the walls, *rigor mortis* should be relaxed, as already advised, by soaking in water. Mere inspection may

[*Description of Cuts.*—Fig. 1. Eccentric hypertrophy as a result of chronic adhesive pericarditis in a man aged 26 years. Weight of heart with pericardium, 1328 Gm. (44 ounces). Valves competent. Wall of left ventricle, 2½ cm. thick; of right ventricle, 5 mm. Patient of Dr. F. C. Shattuck, at one time under the care of the writer. Specimen due to the courtesy of Dr. J. H. Wright.

Fig. 2. Boy aged 6 years in the writer's wards with eccentric hypertrophy due to mitral regurgitation. The black line indicates the extent of cardiac dullness. Two attempts to obtain a radiograph were unsuccessful. HERMAN F. VICKERY.]

Of course, the immediate effect of any of the causes of hypertrophy is manifest in the corresponding portion of the heart, and not in the whole

organ. Aortic stenosis and regurgitation enlarge the left ventricle. In time, however, stasis is produced in the pulmonary circulation, and the right ventricle also hypertrophies. Valvular lesions, whether regurgitant or obstructive, cause an appropriate part of the heart to hypertrophy, and then, sooner or later, more or less directly (with one exception) entail increased labor upon all the other portions of the heart. The exception is mitral stenosis, which affects the left auricle, the right ventricle, and the right auricle, and then tends to cause stasis in the general venous return, with consequent obstruction to the outflow of blood from the left ventricle and aorta into the arterial capillaries; but this obstruction to the expulsive efforts of the left ventricle does not result in hypertrophy of that portion of the heart, because so little blood is admitted into it through the stenosed mitral valve.

The enlargement of the heart in cardiac hypertrophy is due principally to a hypertrophy of the muscle fibers without an increase taking place in their number. There is a tendency toward uniformity in breadth of the fibers.

The reduction in size of the heart in atrophy is due to a reduction in size of the muscle elements, with a decrease in the number of fibers of the whole heart.

The approach to uniformity in breadth of the fibers in the hypertrophic and atrophic heart, as compared with the normal, gives a new conception of variability as affecting the cardiac muscle in its adaptation to abnormal conditions. Karsner, Saphir and Todd (Amer. Jour. of Physiol., July, 1925).

The greatest hypertrophy occurs in aortic regurgitation (*cor bovinum*). There is first eccentric hypertrophy of the left ventricle. When this reaches

sufficient size, there arises relative insufficiency of the mitral valves, and thereupon hypertrophy of the left auricle and the right side of the heart.

The inevitable result of hypertrophy is eventual debility and failure. By the time of death dilatation may far surpass hypertrophy; or the hypertrophied muscle may be more or less changed by fatty degeneration.

**PROGNOSIS.**—As just stated, the condition must terminate unfavorably. So long, however, as the hypertrophy compensates for the obstacle which



Fig. 2.—Eccentric hypertrophy due to mitral regurgitation.

rises to it, or grows proportionally with any augmentation of that obstacle, the patient may feel perfectly well. Even during this time of perfect compensation he may, however, suffer from cerebral hemorrhage or (if the hypertrophy affects the right ventricle) pulmonary hemorrhage. Escaping these dangers, he may do well for years, but finally dies, either from dilatation or fatty degeneration or the failure of innervation already mentioned.

**TREATMENT.**—The care of a patient with hypertrophy demands that we should allow nothing to aggravate the condition, and should in every way possible promote the nutrition of the myocardium. The etiology must be

considered. Tobacco and alcohol must be forbidden and excitement and worry averted. Simple, nutritious food should be taken regularly in moderate quantity. It would be better to permit lunches than the ingestion of a large amount at one time. Moderate and habitual **exercise** is beneficial. The exact amount and character may be determined partly by the experience of the patient; dyspnea and palpitation are not to be caused by it. If there is discomfort and throbbing in the left chest, **bromides** may be useful, or a drop or two of tincture of **aconite**, or **veratrum viride**, thrice daily. In a stout patient an occasional **saline purge** may be useful.

A daily cool bath, with rubbing, is a good tonic. Hot baths and Turkish baths are unfavorable or dangerous.

In overhypertrophy of the heart direct depressants (aconite, etc.) are rarely needed. The more concentrated forms of food should be used very sparingly, and the daily quantity should be slightly less than that required in health. Tea, coffee, alcohol, and smoking must be prohibited. **Physical exercise** should be of the gentlest sort; if the patient's occupation tends to stimulate the heart, it must be immediately abandoned. A mild saline purge (3ij to 3ss—8 Gm. to 15 Gm.—of **Rochelle salts** once daily) is beneficial.

For relief of vertigo, head fullness, and precordial discomfort, particularly when arteriosclerosis is a traceable cause, **nitroglycerin** in full doses and **veratrum viride** are most useful; the efficacy of both may often be enhanced by the **bromides**. In nervous cases the bromides, with **valerian**, are the most valuable agents. Nothing, however, is more important than the determination and removal of the cause when possible. J. M. Anders ("Textbook of the Practice of Medicine." 1920).

## DILATATION OF THE HEART.

**DEFINITION.**—Increase in the size of the heart, due to enlargement of one or more of its cavities. Clinically, "dilatation" is applied to an enlarged, but failing, heart displaying the phenomena of "ruptured compensation." However, dilatation may be either useful, *i.e.*, compensatory, or harmful. When the heart is called upon to do more work, it is aided in its efforts not only by the hypertrophy of the muscle, but also by the enlargement of the cavity upon which the stress of the work falls, for in this way a larger amount of blood is pumped out of the heart with each systole. As long as the hypertrophy keeps pace with the dilatation, the latter is advantageous. When dilatation develops more rapidly than hypertrophy, symptoms of broken compensation occur.

**VARIETIES.**—"Simple" dilatation is the term used to denote that condition in which the walls of the heart remain of comparatively normal thickness. Inasmuch, however, as the cavities, and consequently their walls, are more extensive than normal, simple dilatation is associated with a certain amount of hypertrophy. Dilatation is "hypertrophic" when the heart walls are thicker than normal. Another name is "active dilatation," and viewed from the opposite standpoint it becomes "eccentric hypertrophy." In "atrophic" or "passive dilatation" the walls are thinner than normal.

Most cases of dilatation are essentially chronic in their development and progress. Some, however, are acute.

**SYMPTOMS.**—Usually the earliest indication to the patient of his trouble is shortness of breath. This at first is apparent only upon exertion, but

in well-developed cases it becomes a source of great suffering. Hardly more than one word can be uttered without a pause for breath, and sleep, if obtained at all, is possible only in the vertical position (orthopnea). The ordinary automatic respiration has sometimes to be supplemented by voluntary efforts; so that when sleep does come the dyspnea becomes aggravated and soon wakes the patient.

Another early symptom is palpitation with a sense of discomfort or oppression in the cardiac region. It is singular that the powerful heave of an hypertrophied heart does not seem to obtrude itself upon the consciousness of the patient so much as the feeble flutter of dilatation. There may also be a cough, with white, frothy, serous expectoration. The imperfect circulation in the brain is evidenced by more or less mental slowness and easy fatigue, with impaired memory, drowsiness, despondency, ill temper, and attacks of faintness. In the digestive tract the passive congestion of the stomach is evidenced by fermentation, heaviness, nausea, and even vomiting. The bowels are usually sluggish, and the urine is scanty and high colored, with a deposit of urates.

The differentiation between physiologic and pathologic dilatation depends solely on clinical manifestations; the distinction cannot be made by the pathologist from examination of the heart alone. Myocardial degeneration is sometimes less important in the explanation of a cardiac death than the clinical evidence of overwork, as in hypertension, valvular lesions or the increased rate in goiter. An excellent example of cardiac dilatation where overwork is obviously an important factor is auricular fibrillation; by continually holding down the rate with digitalis, the tone can be kept intact

in these cases. In lesser degrees of tonus depression there may be for weeks or months only nocturnal dyspnea and breathlessness on exertion. Objective phenomena of more pronounced loss of tone are orthopnea, dropsy, cyanosis and albuminuria. There may be some precordial distress, but severe pain is rare. When tonus becomes impaired in angina pectoris, the attacks of angina usually cease. Absence of a murmur does not exclude dilatation; yet the systolic murmur caused by diminished tonus of the muscular ring surrounding either auriculoventricular orifice may be one of the earliest signs of dilatation. Such a murmur may occur, indeed, in physiologic dilatation. P. T. Bohan (*Ann. of Clin. Med.*, May, 1924).

In mild degrees of dilatation the complexion is pale; in more advanced cases, dusky or cyanotic, with blue lips and finger-nails. The extremities are apt to be cold to the touch, and the sluggishness of the capillary circulation is illustrated by the slow return of color to any point of the surface after firm pressure: the shape of the examiner's hand is, as it were, stenciled upon the cyanotic surface. The labored breathing is noticed even while the patient is at rest, but becomes striking upon the least exertion. Edema appears first in the ankles, thence creeps upward to the thighs and pudenda, and finally invades even the face and arms. Ascites and hydrothorax are often present. It is not unusual to find a considerable amount of fluid in one side of the chest, usually the right, while the other presents merely the signs of edema. The eyes are somewhat prominent and glassy. Frequently the liver is painful, tender on pressure and much enlarged, reaching even to the level of the navel. This change in its size may be more or less obscured by the

ascites present, but in that case can often be demonstrated by a quick, though gentle, pressure of the fingers inward ("dipping"). In some cases the spleen is also found to be enlarged.

The pulse is of great importance in regard both to diagnosis and prognosis. It is apt to be frequent, ill sustained, and irregular in force and rhythm. The number of radial pulsations may be considerably less than the number of heart-beats as counted with the stethoscope. The pulse-wave is apt to be small, but in cases where previous high tension, or arteriosclerosis, has dilated the peripheral arteries the wave may be of considerable volume.

The phenomenon known as *bigeminal pulse* is quite frequent in cases of dilatation. Often the second and weaker of these twin cardiac impulses fails to reach the radius in perceptible strength. Inspection of the cardiac region shows no such bulging as may be present in cases of hypertrophy, except when the precedent hypertrophy has left its traces behind it. It may be difficult to locate the apex-beat by the eye, or the impulse may seem to be diffuse and not to impinge upon exactly the same point with every beat.

Over other portions of the heart than the apex the intercostal spaces may sometimes be seen to protrude and recede with the action of the heart, and sometimes an extensive wavy motion may be observed over the cardiac area. When the right ventricle is dilated, there is sometimes a marked impulse in the epigastrium below and to the right of the xiphoid.

Upon palpation the heart beat is found not to be of a strong and heaving character, but feeble and resembling a quick tapping or slapping of the chest, sometimes with more or

less of a tremulous sensation imparted to the hand. Even when the eye has detected the apex-beat, the hand may not be able to distinguish it. The most satisfactory mode of practising palpation is by resting the whole hand, as lightly as possible, over the precordium, and then testing the impressions thus received by firmer pressure and by digital touch.

Percussion shows an increase in the area of cardiac dullness varying somewhat according to the portion or portions of the heart mainly dilated. Increase in the size of the right ventricle makes the heart broader than normal, but not much longer. The right limit of dullness may, in such a case, reach or even extend beyond the right nipple. Enlargement of the right auricle is associated with increase of dullness at the right edge of the sternum, corresponding to the second and third intercostal spaces. According to Harris, in dilatation due to mitral stenosis all dullness to the right of the sternum is due to enlargement of the right auricle. The dilated left ventricle presents an area of cardiac dullness not much wider toward the right than normal, but extending downward to the seventh or eighth intercostal space, and perhaps an inch or two to the left of the normal position of the apex.

By means of auscultation we may, in the first place, be able more exactly to locate the position of the apex-beat than by either inspection or palpation, assuming that it corresponds to that point where the first sound of the heart is loudest. The first sound of the heart in cases of dilatation may be louder than normal, but it is devoid of muscular quality, being short and valvular; that is, closely resembling

the normal second sound of the heart. It is heard with more distinctness in the aortic area than is the first sound of the hypertrophied heart. Frequently there is also heard a systolic murmur at the apex, due to regurgitation through the mitral valve or tricuspid, because the auriculoventricular opening is dilated as well as the ventricle, and consequently has become too large for the valve, even though normal, to close it efficiently (relative insufficiency). The second sounds at the base of the heart are of variable character in different cases. If they are tolerably sharp and distinct they are somewhat reassuring, as indicating that the ventricles still possess muscular power. Another important point (W. H. and J. F. H. Broadbent) is the length of the pause between the first and second sounds of the heart as compared with the pause separating one cardiac cycle from another. If the first and second sounds are separated by a shorter interval than in health, we must infer that the dilated ventricles are able to make only an ineffective effort at systole.

When tricuspid regurgitation exists, the veins in the neck are dark and turgid. Their valves show like knots. Often actual pulsation in them may be demonstrated, especially if the patient takes a horizontal position. Pressure upon the congested liver magnifies the engorgement of the jugulars. Compression and extreme displacement of the esophagus is also liable to occur.

Small hearts with thin walls, unable to hypertrophy, do not get dilated. Dilatation being a compensatory mechanism, such patients die very quickly if the heart becomes insufficient. Conversely, the big strong hypertrophic

hearts can be repeatedly dilated without having ever caused a deficiency of circulation. E. Weiser (Wien. klin. Woch., Jan. 30, 1923).

**DIAGNOSIS.**—From pure *hypertrophy* dilatation can be clearly distinguished by the general aspect of the patient, and the evidences of imperfect and failing circulation already detailed. In both conditions the area of cardiac dullness is increased, but in dilatation we do not observe the strong heaving impulse of hypertrophy. In general, it may be said that the two are opposites. Hypertrophy is an exaggeration of the normal state, while dilatation is a condition of weakness and failure.

The first sound of the hypertrophied heart at the apex may not be so loud or distinct as in dilatation, being low and muffled, and, as already stated, it may be inaudible at the base; but there is present in it a muscular quality, distinguishable in a less degree over the apex of a normal heart, and not heard in cases of dilatation.

The hypertrophied heart must at last, however, enter into the state of dilatation,—unless its owner is the victim of intercurrent disease,—and it becomes important to determine what degree of deterioration has already been reached.

Very valuable information in doubtful cases with regard to the integrity or otherwise of an enlarged heart may be obtained by causing the subject under examination to make somewhat brisk muscular exertion, as by ascending and descending a flight of stairs or by hopping six or eight yards upon one foot. The degenerated heart will become unnaturally accelerated and irregular, while a well-nourished heart will act even better than before.



In certain cases *retraction of the lung*, as in chronic phthisis, leaves a comparatively normal heart more exposed than in health and might occasion a mistake of the condition for one of dilatation. Factors in this diagnosis would be the history of the case, the signs of pulmonary disease, the absence of venous stasis in other parts of the body, and the fact that the border of the lung near the heart does not extend inward over the cardiac area on full inspiration.

For the diagnosis of dilatation of the left auricle, the writers employ moderate percussion posteriorly. This elicits paravertebral dullness near the 3d and 5th thoracic vertebrae, the area being oval and measuring about 4 or 5 finger-breadths. This unusually high position of the dullness is explained by displacement of the left bronchus. II. Elías and K. Hitzemberger (Wien. klin. Woch., Apr. 9, 1923).

In a patient with dyspnea and palpitation, the author elicited a large area of dullness to the right of the midline, continuous with the cardiac dullness, reaching up to the 3d right intercostal space and well beyond the right midclavicular line. In the 3d space the dull area revealed a systolic murmur. Pulsation in the same space outside the midclavicular line was also present. The diagnosis of horizontal dilatation of the left auricle was confirmed by X-ray and at autopsy. II. Batty Shaw (Lancet, Sept. 6, 1924).

*Mediastinal tumors* may cause dullness in the cardiac region, but they are apt to extend upward and to the right or left side, and the heart sounds are not audible over them in the same way as over the dilated heart. In *thoracic aneurism* we should expect to find a heaving impulse in the neighborhood of the base of the heart, with other positive signs of aneurism and without the changes in

the cardiac sounds and impulse or in the general circulation seen in dilatation.

A more difficult question is to distinguish *pericardial effusion* from cardiac dilatation. In certain cases this seems to the writer almost impossible, although in the great majority of instances a definite conclusion can undoubtedly be reached. Dullness above the third rib suggests the possibility of pericardial effusion. In pericarditis we are more apt to have a history of an acute onset with fever, pain, and pericardial friction sounds, and perhaps, also, knowledge of a nephritis, or tuberculosis, or acute pneumonia as etiological factors in the production of pericarditis.

The pericardial effusions give an area of dullness somewhat more pear-shaped than that seen in dilatation of the heart, which is, more or less, quadrilateral.

The angle formed by the right border of cardiac dullness and the upper border of liver dullness is acute in health. In this condition it is usually obtuse, but a dilated right ventricle may cause a similar dullness. The left border of cardiac dullness does not correspond with the apex impulse, but is farther to the left. In the left back at the angle of the scapula there may be a small area of dullness and bronchial breathing. Pericardial effusion also raises the apex beat upward and outward toward the third or fourth spaces in the neighborhood of the left nipple, and it renders the heart sounds less distinctly audible than in dilatation. It may also cause a paradoxical pulse. Yet, in case of valvular heart disease with a fresh attack of rheumatism, a recent pericarditis friction sound, and evident failure of compensation, it

may be very difficult to determine whether the increased area of dullness on the right side of the sternum is referable to pericardial effusion or to dilatation of the right ventricle, particularly as the dilatation often develops with great rapidity.

In *emphysema* a dilated heart may not be recognized because of unnatural pulmonary resonance encroaching upon the true cardiac area. Here we may be saved from error by the history of chronic bronchitis, and of already established and slowly increasing dyspnea, as well as by the characteristic pulmonary signs. Also, the Röntgen ray may be employed.

Repeated orthodiagraphic examinations give much information on the course of dilatation of the heart. Percussion by experts yields serviceable data, but is not accurate enough to show any but marked changes of size of the heart. In localized and slight changes orthodiagrams are far superior. In hypertrophy the process of enlargement of the organ is observed by orthodiagraphy to go on steadily, while in dilatation there is a series of acute enlargements followed by rapid reductions of size. If, however, in dilatation there is a chronic process going on, each successive reduction fails to attain the size that existed before the corresponding acute enlargement. E. Bordet (Paris méd., July 4, 1925).

**ETIOLOGY.**—Increase in the cavities of the heart must be due either to abnormal weakness of their walls or excessive labor in the propulsion of the blood-current. Among obstacles to the circulation should be enumerated valvular disease, arteriosclerosis, chronic interstitial nephritis, atheroma, obesity, emphysema, and congenital narrowness of the aorta. Contrary to what might be presupposed, thoracic aneurism does

not cause change in the heart walls, unless associated with aortic regurgitation. Pericardial adhesions may cause dilatation of the heart, more especially when the outer surface of the pericardium is fastened to the chest wall or diaphragm.

Exophthalmic goiter and tachycardia cause cardiac dilatation and, according to some writers, excesses in tobacco and venery, great anxiety and despondency, leukemia, anemia, and chlorosis.

Habitual, severe, and sustained physical exertion may eventuate in cardiac dilatation, as seen in both athletes and in men following laborious occupations. Dilatation may, indeed, ensue upon a single violent or prolonged muscular effort. In many cases of this sort it is presumable that the myocardium was previously in a vulnerable condition; but yet dilatation may occur in young and apparently healthy men after mountain-climbing, and, after a period of due rest, be completely recovered from. In other cases, however, especially in persons with less elasticity of constitution, the lesion is a permanent one and progresses to a fatal termination. The danger of engaging in athletic competitions without proper training is obvious.

Other causes are: acute nephritis, as after scarlet fever; rheumatic pericarditis and myocarditis, pneumonia, and typhoid fever. Influenza certainly may precipitate dilatation, if it does not actually cause it. Diphtheria is a prolific cause of dilatation owing to infection of the myocardium.

High tension in the systemic arteries, aortic stenosis, and aortic regurgitation cause a predominant change in the left ventricle as compared with the other cavities.

In aortic regurgitation the dilatation is beneficial within certain limits. Inasmuch as a certain portion of the blood forced into the aorta with each systole is at once allowed to return to the ventricle, the total amount of blood forced out with the systole must be greater than in health, or there will inevitably

ever, is enlargement of the right side of the heart: at first of the right ventricle, and, when it begins to fail, also of the right auricle. The right auricle seldom undergoes much hypertrophy; any increase in its size is apt to be a pure dilatation.

The stress of mitral stenosis, pulmo-

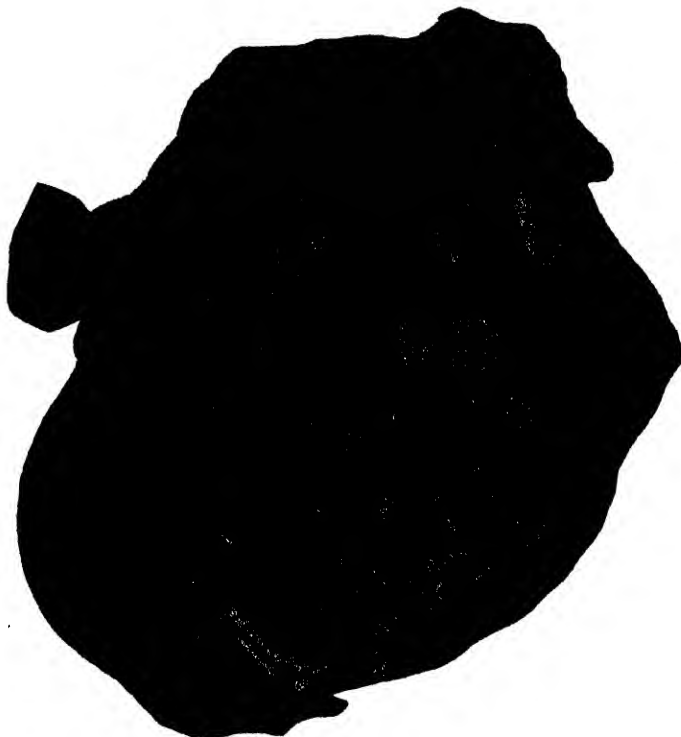


Fig. 1.—Dilated left ventricle with a cardiac aneurysm at apex. Case of chronic interstitial myocarditis in a man aged 84.

be a diminution in the normal amount in the arterial system. In its final development aortic insufficiency presents dilatation of all the cavities of the heart. In case of mitral regurgitation there is also dilatation of the left ventricle, because a leak in the mitral valve during systole overdistends the left auricle, and during diastole the blood rushes into the left ventricle under more than normal tension, enlarging its cavity. The usual and chief effect of mitral lesions, how-

nary stenosis, and chronic pulmonary disease falls upon the right side of the heart. Predominant dilatation of the right ventricle makes the heart globular in shape. The enlarged right ventricle overlaps the left ventricle, except at the left border of the heart.

An examination of the minute structure of the myocardium in dilatation may show either interstitial myocarditis or fatty degeneration, or there may be no change in the heart-fibers appreciable

even with the microscope. In certain of these cases it would seem probable that the nervous ganglia connected with the heart may be at fault. In marked dilatation the pectinate muscles themselves are flattened into mere tendinous cords.

[The accompanying illustrations are from photographs of specimens in the Warren Museum in the Harvard Medical School, for advice and assistance in ob-

to the liver and digestive tract. Each case should, therefore, be carefully considered on its own merits or demerits.

The most acute transitory form of dilatation is probably that which occurs in athletes and others under great or long-continued effort. The majority of these persons, if in good health and well trained, seem to escape permanent injury. It will be found, however, that



Fig. 2.—Excessive dilatation, with hypertrophy, of the right ventricle. Valves of pulmonary artery united to form a smooth fibrous diaphragm with a small opening in the center. Left ventricle laid open, not enlarged. Case of a boy aged 14. Cyanosis, dyspnea, sudden death.

taining which I am indebted to the courtesy of Dr. William F. Whitney, Curator. HERMAN F. VICKERY.]

**PROGNOSIS.**—It will be seen from what has gone before that dilatation of the heart is a condition in which it is not proper to generalize when considering any individual case. The state might be said to bear the same relation to heart conditions that jaundice holds

a certain important proportion of those who engage in violent and desperate, competitive physical exertions, as, for instance, a long boat race, suffer for years thereafter from discomfort in the cardiac region, with some tendency to irregularity of the pulse.

Those who train athletes should appreciate this possibility. The first degree of dilatation and consequent venous

stasis is shown by pallor, for this reason: as the left ventricle becomes tired, blood accumulates in the right side of the heart and the systemic veins in more than normal amount, yet not exceeding the capacity of the venous system. As a consequence of this increase of blood in the venous channels, there is less blood than normal in the arteries, causing a pal-

disease. Here, too, sudden progress in the wrong direction may occur as the result of overstrain,—changing a moderate into a severe case.

In general, it may be said that the patient does not often survive a well-marked degree of cardiac dilatation for more than 12 to 18 months.

According to Blake's rough approximation, a dilatation extending out-



Fig. 3.—View of the right ventricle of the same heart.

lor which does not advance to cyanosis until a much greater amount of blood is present in the veins. If, then, a person engaged in vigorous exercise changes from the ordinary pink flush of countenance to a decided pallor, the limit of safe exertion has been reached. Cyanosis conveys a still more imperative warning.

With regard to the more common and usually slowly developing forms of dilatation, it should be said that there may be many degrees of the

ward to one fingerbreadth beyond the nipple line is usually recovered from; two fingerbreadths mean an exceedingly dangerous condition, while three fingerbreadths is usually fatal. Vomiting in a case of dilatation is usually the precursor of sudden death.

The factors upon which we should lay weight in determining the reserve power of a dilated heart are of two kinds, rational and physical. If the disease has come on in one whose habits can be greatly changed for the better, with

regard either to overindulgence in alcohol, tobacco, the pleasures of the table, and such like, or sorrow, anxiety, overwork, and long hours of sustained effort, then the chances are somewhat more favorable than if the subject has led a physiologically blameless life. The judiciousness or unsuitableness of the treatment heretofore adopted should also be considered. And those who

obtain for the patient a fair degree of sleep and maintain a sufficient nutrition of the body.

It is oftener possible to produce a certain degree of improvement than to maintain it, to say nothing of completing the recovery.

A fatal termination may be preceded by attacks of syncope, often most alarming; but death is more apt to come at

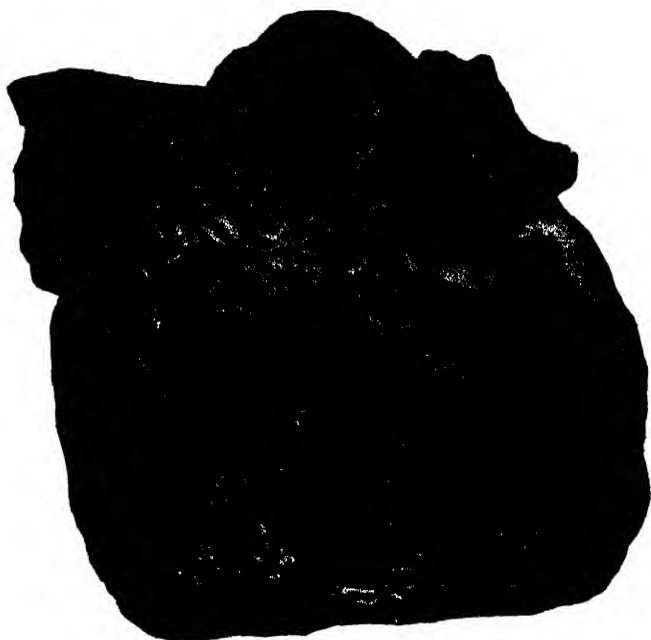


Fig. 4.—Left ventricle greatly dilated, but its walls of normal thickness. Aorta extremely atheromatous and enlarged. Man aged 44. Cardiac symptoms of pain, dyspnea, and palpitation for ten years. Death in a seizure.

have previously undergone one or two attacks of cardiac failure are to be regarded in a more dangerous condition than during their previous illnesses.

Irregularity in the pulse is not necessarily of evil import, but a great frequency of the pulse rate is discouraging. Of course, any degree of vigor in the cardiac impulse is a welcome discovery, as is also a sharp and decided quality in the second sounds at the base of the heart. The case may be considerably affected in its course by our ability to

the end of a comatose condition than with extreme suddenness. Embolism and thrombosis may also prove terminal factors.

**TREATMENT.**—Absolute rest in bed is very desirable if the patient is able to enjoy it. In many cases, however, the sufferer cannot assume the horizontal position, but is obliged to sit either propped up in bed or in a chair where he may bend his knees. For such unfortunates sleep is often best obtained by providing them with a shelf or rest

in front of them at about the level of the elbows, on which they may lean, bending forward. There are special tables made with a leaf reaching over the bed.

The diet is of great importance. It should be bland, easily digested, and given in small amounts at intervals of two or three hours. The total intake of fluids should be limited to 1500 or even 1000 c.c. (1 quart) in the twenty-four hours. Some cases



Fig. 5.—Dilated left ventricle, showing trabeculae flattened and indistinct. Mitral valves extensively destroyed and covered with large vegetations.

have seemed to do well on a strict milk diet, particularly such as have suffered from high arterial tension. In most, however, a variety of rather concentrated, but simple viands is preferable. Thus we may allow eggs, fowl, underdone beef or mutton, beef-juice, buttermilk, and gruels made with one-half milk and one-half water. Alcohol should be reserved for emergencies.

In acute dilatation, rest in the most comfortable position is essential. Digitalis is not to be given until the patient gets up. A sedative, as mor-

phine, is indicated for excited and worried patients. The diet should be adjusted according to the fluid retention, the chemistry of the blood and urine, and the extent of edema. Patients with pure heart disease do well on meat. Heart stimulants should be used only if the symptoms cannot be relieved by rest. In some cases *strophanthus* is more effective than *digitalis*. Caffeine, as in black coffee after meals, ranks next in value. Strychnine increases the irritability of the heart muscle and has a favorable action in chloral poisoning and certain toxemias. Adrenalin intravenously has a great but transitory effect in stimulating a depressed heart. Edema and dyspnea may be relieved by posture, by causing the bowels to move, and by insuring enough sleep with chloral hydrate, bromides, morphine or codeine. Cardiac pain may be relieved by digitalis intravenously or by cold, heat or cupping over the heart. Bronchitis calls for cough-allaying mixtures. Insomnia is often relieved by hot packs and diuretics. In nausea, morphine should be given first, and then digitalis. Harlow Brooks (Long Isl. Med. Jour., June, 1923).

Constipation and flatulence interfere with abdominal respiration and impede the venous circulation. Laxatives are consequently of great value, and more especially hydragogue cathartics. Enlargement of the liver increases the advisability of their employment. In suitable cases the relief from a purge is almost magical. It seems to produce the same mechanical effect that venesection would without the loss of strength which the latter measure involves. The favorite drug is mercury, either in the form of blue mass or the mild chloride. This may be followed the next morning by a dose of sulphate of magnesium or sodium in concentrated solution. The advantage of mercury over other cathartics is that it not only

depletes the veins, but dilates the capillaries, and thus lessens the obstruction which the weakened heart has to overcome. Another efficient and not very unpleasant remedy for the same purpose is composed of equal parts of **bitartrate of potassium and compound jalap powder**, of which the dose is 1 or 2 teaspoonfuls.

In a patient enfeebled by long illness, active purgation as a measure preliminary to digitalis will tax the little remaining strength severely. This is avoided by giving fractional doses of **calomel** at 15-minute intervals until the bowels have been freely opened. In a "water-logged" case **compound jalap powder** in 20-grain (1.25 Gm.) doses will assist; **theocin sodioacetate** and **caffeine** are also valuable in suitable cases. For sleeplessness, **chloral hydrate**, 10 grains (0.6 Gm.), with **ammonium bromide**, 10 to 20 grains (0.6 to 1.25 Gm.), is reliable, though in some instances **morphine**,  $\frac{1}{4}$  grain (0.015 Gm.), is required. Thorough mastication should be insisted upon. Farinaceous foods should be taken sparingly because of their tendency to provoke flatulence. When it is difficult to get nourishment down from urgency of symptoms, whites of eggs in lemon barley-water is a useful way of giving support without the patient's knowledge. C. W. Chapman (Practitioner, June, 1924).

The best cardiac stimulant is **digitalis**. It should be given in efficient doses. If the desired effect is not obtained with ordinary amounts, the remedy should be gradually pressed until either there is improvement or nausea interferes with its further administration. In some cases it may be given by means of an enema, subcutaneously, or intravenously, when the stomach altogether rejects it. Its well-known cumulative action should be remembered, and it should not be longer continued if nausea begins or

the amount of urine diminishes. In fact, practically, one must be ready to suspend it about as soon as it produces a marked satisfactory effect (see **DIGITALIS**). As substitutes for digitalis, tincture of **strophanthus**, **caffeine**, and **sparteine sulphate** may be employed, their probable efficacy being in the order named.

In a man of 40 years a fall from a height was followed by acute dilatation of the heart, with edema. Under **digitalis** the symptoms gradually subsided, and by the 17th day the condition was normal. Sarachaga (Rev. de med. y cir. pract., Jan. 7, 1919).

Dilatation may result from subjection of the heart to exertion for which it has not been properly trained. As the organ dilates the coronaries are stretched in length and narrowed in diameter, with a consequent reduction of blood-carrying power, which may easily reach 50 per cent. or more. The heart is then doing more work than normally with less nourishment than usual. A heart that is dilated or in danger of being dilated needs **digitalis**. The writer gives 30-drop doses of the tincture at short or long intervals as indicated. In severe cases an initial dose of 1 dram (4 c.c.) or more may be administered. O. H. Brown (Jour. of Lab. and Clin. Med., May, 1923).

Josué described a group of cases with dilated heart, low blood-pressure, "white line" phenomenon, dyspnea and sometimes arrhythmias, in which digitalis fails but **adrenal preparations** have a manifest beneficial action.

The preparations of **iron** are useful for their beneficial effect upon the nutrition of the heart-wall. **Quinine** and **arsenic** are advised in certain cases. The latter sometimes appears particularly efficient in cases where there is cardiac pain.

In a case of acute heart dilatation in a girl of 20 years, the writer observed



the pulse, previously 224, return promptly to normal after a single hypodermic injection of **morphine**. During the period of recuperation in such cases he uses **arsenic** and the **hypophosphites**. T. R. Davison (*Se-mana med.*, June 3, 1920).

**Massage** may do good in two ways, both by promoting general nutrition and by assisting in the propulsion of the blood. The **Schott method** of treatment may be of advantage in less alarming cases where there yet remains some muscular integrity in the heart (see p. 298).

The **Oertel method** of treatment is suitable in so far as the amount of liquid ingested may often be limited to advantage, but unsuitable with regard to the forced muscular effort he advised.

Fluid in the abdominal or thoracic cavities should be withdrawn. It is sometimes surprising how much benefit will follow the removal of 12 or 16 ounces of water from the chest or a few quarts from the abdomen, *i.e.*, **paracentesis**.

The legs in some instances are immensely distended with fluid. Bullæ are apt to form, which burst spontaneously and exude dropsical fluid. Large amounts of water may sometimes be drawn from the lower extremities through **Southey's capillary trocars** or by means of **longitudinal scarifications**. A practical objection to the latter method is the great danger of erysipelas attacking the scarified tissues. Apart from that, the constant dripping day and night torments the patient and soon causes more or less eczema of the skin. But the relief to the circulation is, in some instances, worth even the immense amount of trouble and the considerable risk thus entailed.

Where **digitalis** fails in circulatory failure, **apocynum** may be used. It is important not to overlook a large effusion, which acts as a hindrance to the heart and prevents it from reacting to treatment. A single **tapping** may change the complexion of the case completely, or 2 or 3 tapplings may be required. Where there is obstinate dropsy, with face puffy and cyanosed and the serous cavities filled, excellent and lasting results may follow **scarification of the legs**. The writer usually makes about 6 cuts 1 to 1¼ inches long on the outer and inner aspects of the leg below the knee. The incisions are carried into the subcutaneous cellular tissue. A little blood may flow at first, but it soon gives place to a continuous stream of watery serum. **Southey's tubes** have no great advantage over scarification. Infection is rare in either case, the serum being in a measure bactericidal. D. Riesman (*Ill. Med. Jour.*, Dec., 1925).

For the attacks of syncope to which these patients are liable, the subcutaneous injection of **digitalis**, **ether**, **alcohol**, **camphor**, **caffeine**, or **strychnine** is necessary. Of late the glucosid **strophanthin** has been employed intravenously in doses of  $\frac{1}{240}$  to  $\frac{1}{60}$  grain (0.00027 to 0.001 Gm.). It cannot be given safely if **digitalis** has just been administered, nor repeated within twelve hours. Sometimes its efficiency is marvelous. Marked relief and apparently valuable stimulation are sometimes obtained by the **inhalation of oxygen gas**, which has once or twice seemed to the writer actually life-saving in its efficacy. In such cases, however, a fatal termination is merely delayed, not absolutely prevented.

**Intracardiac injection of adrenalin**, 1 c.c. (16 minims), was employed by the writer in 4 cases of heart failure, with 2 permanent successes. He regards such injections as free of danger. The internal mammary can be

avoided by puncturing close to the border of the sternum or 3 cm. to the left of it. He prefers puncture at the apex beat or the left boundary of heart dullness. A long needle is inserted upward and backward until blood enters the syringe. The circulation once started must be supported by **intravenous injections of adrenalin**, or by infusion of 150 c.c. (5 ounces) of 10 per cent. **glucose solution** with 15 drops of adrenalin. He finds that 0.5 c.c. (8 minims), or even 0.25 c.c. (4 minims) of adrenalin is enough for the first injection, to be repeated in 3 hours. **Pituitary extract**, which acts similarly, may be combined with it. W. Greuel (Berl. klin. Woch., Nov. 21, 1921).

Good results are sometimes obtained from **venesection**, particularly in the cases of dilatation of the right ventricle attending emphysema.

Aortic disease or arterial hypertension may be complicated by sudden distention of the left ventricle, inducing attacks of severe anginal pain, the latter constituting a decubital angina, to be distinguished from the form of angina following exertion. The pain is preceded by dyspnea and other evidences of cardiac inadequacy. It occurs especially during sleep and is not checked by immobility. In cases of hypertension the attack is often brought on by cold, causing abrupt vasoconstriction which may not pass off until the following morning. Such attacks may be treated by **venesection** and heart tonics, especially **ouabain**, 0.25 mgm. ( $\frac{1}{200}$  grain), given intravenously and repeated in a few hours. Lutembacher (Presse méd., Apr. 1, 1922).

X-ray examination of a series of decompensated hearts in patients with failing circulation usually showed a diminution in the size of the heart immediately after **venesection** (500 to 900 c.c.). When this diminution, ranging from 1.0 to 2.3 cm. in the transverse diameter of the heart, occurred, there was a corresponding improvement in the patient's condition.

The diminution appeared within a few minutes, and sometimes there was a further reduction later. The symptoms relieved by venesection are, especially, dyspnea, cough, restlessness, and the appearance of suffocation and cyanosis.

Pulmonary edema is mentioned in hospital records as being relieved considerably after venesection. Many patients, bled as an emergency measure after drugs, etc., had failed, possibly because of their delayed action, have responded favorably to venesection. The latter has a place in removing, temporarily at least, the signs and symptoms of cardiac failure. Absence of response to venesection in a portion of the author's cases is ascribed to certain anatomic changes in the myocardium. Burgess Gordon (Amer. Jour. Med. Sci., Nov., 1925).

## PERICARDIUM, DISEASES OF THE.

### PERICARDITIS.

**DEFINITION.**—Pericarditis is characterized by inflammation of the pericardium, the result of primary or secondary infection—usually the latter.

**SYMPTOMS.**—The subjective symptoms may vary greatly in severity. In mild cases the disease may call no attention to itself, and its discovery can only be made, if at all, by means of careful physical examination.

In severer cases there is uneasiness or pain in the cardiac region, with moderate fever and a general feeling of bodily distress. An important symptom is shortness of breath. There may also be palpitation, tenderness in the precordial region, and a dry cough. As fluid accumulates in the pericardial sac, the symptoms change correspondingly, the heart's action being more embarrassed (especially its diastole), the dyspnea and sense of anxiety increasing, yet pain,

on the other hand, diminishing. In young children pain is usually absent, although on the other hand, cases have been reported in which a diagnosis of appendicitis had been made.

A little nausea or vomiting may be the only evidence of the onset of acute pericarditis in children, unless the physician notices the fact that the pulse is weak and compressible and the heart sounds distant or weakened. Insidious pericarditis is a common occurrence, frequently following left-sided pleurisy with effusion. The writer advocates *digitalis* and *iodide* to obviate subsequent adhesions. Baumel (Méd., Aug., 1921).

It has been stated that the pain is greater in pericarditis with effusion than in merely fibrinous pericarditis. This statement applies, so far as regards cases with effusion, to the time before the effusion develops.

The pulse at first is apt to be rather forcible; in later stages it becomes irregular, intermittent, and of low tension. The disturbance of cerebral circulation is shown by wakefulness, headache, and in severer cases dullness, delirium, or even melancholia. Rare complications are chorea and epilepsy.

Great distention of the pericardial sac may occasion dysphagia, which may be lessened if the patient is raised into a sitting posture or bends forward. Sometimes the difficulty in swallowing appears to be due merely to nervous disturbance. There may likewise be vomiting, of nervous origin, because of irritation of the recurrent laryngeal nerve. Balfour warns us that the occurrence of delirium in the course of rheumatic fever ought at once to direct attention to the heart.

As regards objective symptoms,

the disease may, as already said, run its course without directing the patient's attention to its existence; likewise the disease may escape the persistent and assiduous efforts of the physician to discover it. In general appearance the patient is apt to be anxious, distressed, and have a dusky countenance.

Before any effusion has accumulated in the heart-sac there may be tenderness or friction over the cardiac area; there is not apt to be great enlargement of the heart, although it may become somewhat dilated. In the early stages of the disease the heart's impulse is somewhat exaggerated, but later it becomes feeble. The veins of the neck may be distended or may even display pulsation. If there is considerable effusion, the precordia may be somewhat prominent, especially in children, and the intercostal spaces raised so as to be on a level with the general surface. Sometimes the affected region exhibits edema, particularly when there is pus.

On auscultation it may be possible to detect friction. The apex beat may be felt in its normal condition. As an effusion collects, the apex becomes less easily palpable, and finally disappears. Sometimes, however, it will be discovered if the patient can bend forward, thus causing the heart to approach again more closely to the chest wall.

Gibson states that "the vocal fremitus over the sternal region loses some of its intensity, and even fluctuation has been observed." As fluid collects in the sac, the area of cardiac dullness increases in every direction. The classical description of the shape of the dull area is that it resembles a triangle, or a pear hanging by its

stem, with its base at the lower part of the chest. These shapes are more often exhibited by large than by moderate effusions. The extension of the dullness upward and to the right is quite constant. It is possible that adhesions may modify the position of the fluid. Sears, for example, mentions a case in which the heart lay against the anterior chest wall and  $\frac{1}{2}$  pint of pus had collected behind it.

There are four characteristic points about the enlarged area of dullness: (a) The apex beat, as determined either by palpation or auscultation, is found to lie an inch or two within the left border of dullness. (b) The cardiac impulse is feeble and difficult of appreciation, which would not be the case if the extensive dullness were due either to hypertrophy or dilatation of the heart itself. (c) The normal heart sounds are feeble and distant, while *perhaps* the radial pulse is comparatively strong. (d) The angle formed by the right border of cardiac dullness and the upper border of hepatic dullness is obtuse instead of acute.

Rotch's sign, *viz.*, flatness in the 5th interspace to the right of the sternum, has been largely discredited by Broadbent and Williamson for small or moderate effusions.

In pericarditis with effusion in children, the outer border of the pericardial sac can be located by very light percussion; then, with the stethoscope over the heart, stroking or tapping with the tip of a finger or pencil in a centripetal direction will yield an inner outline corresponding more closely to the heart itself. Repetition of the procedure from day to day will elicit changes in the outer margin according to the existing effusion. S. V. Haas (Jour. Amer. Med. Assoc., Dec. 17, 1921).

Stress laid on downward displacement of the left lobe of the liver as an early sign of effusion; in cases where effusion might be expected, a preliminary determination of the level of the margin of the liver in the midline should be made. C. S. Williamson (Jour. Amer. Med. Assoc., Dec. 24, 1921).

A large collection of fluid may affect the pulse in a peculiar way, which, although not pathognomonic, is of considerable value. The "paradoxical" pulse, as it is called, varies with the cycle of respiration, becoming weaker or imperceptible during inspiration.

The distinctive auscultatory sign of pericarditis is the friction sound. This may be heard over any part of the heart, more frequently, however, at the base than at the apex. It is near the ear, increased by gentle pressure with the stethoscope, and is described in various cases as rubbing, grating, or creaking; it is apt to be somewhat harsh and it may be interrupted, or "jerky." It may be systolic or diastolic in time, more often it is a double murmur, and it may be triple. In any case it is not apt to be exactly synchronous with the systole and diastole of the heart. In this respect, as well as in its nearness to the ear, it differs from the endocarditic murmurs, and it also differs in the limited area over which it may be heard. Jossierand has called attention to a sudden and loud, clanging diastolic second pulmonic sound as an early sign of pericarditis.

Jossierand's sign of pericarditis described as a sharp, clanging quality of the second pulmonic heart sound, constituting a warning of the crethism of the heart as the disorder is becoming established. It proved an early manifestation in their 2 cases, antedating

enlargement of the heart dullness by 4 days in 1 instance and the pericardial friction murmur by 5 days in the other. Dargein and Plazy (*Bull. Soc. méd. des hôp. de Paris*, May 18, 1922).

Until the pericardial effusion has reached 200 c.c. the diagnosis depends almost entirely on a to-and-fro friction rub. After a fairly large amount of fluid is present, the most dependable physical signs are a persisting to-and-fro rub, extension of the cardiac dullness up on the left side, substernal dullness which changes with altered posture, broadening of the heart shadow, the physical signs of an area of compressed lung near the angle of the left scapula, and pushing down of the left lobe of the liver. F. M. Hodges (*Jour. of Radiol.*, Oct., 1923).

The pericarditic friction is not transmitted so far as are valvular murmurs. Friction may not be heard when the patient is lying horizontally, and becomes audible when he sits or bends forward. Sometimes it is heard inside the angle of the left scapula. The intensity of the friction is influenced by respiration, being usually louder during inspiration.

The heart sounds proper are feeble and distant, or they may be drowned by the friction murmur. Cases which present both endocardial and pericardial murmurs are naturally perplexing.

Certain accessory signs in the lung remain to be mentioned. In the case of large effusions the percussion sound in the left axilla at about the level of the nipples is a muffled tympany; posteriorly below the angle of the left scapula the compressed lung may give a slight dullness on percussion and bronchial breathing.

Dullness and bronchial breathing over a portion of the left back, near and below the angle of the scapula, are often said to accompany pericardial effusion, and emphasis is laid on

the presence of a considerable amount of fluid in the pericardium; but such signs are often encountered in cases of acute fibrinous pericarditis with to-and-fro friction and little evidence of effusion. Of 53 patients with acute pericarditis and friction rubs, observed by the author, 39, or 73.5 per cent., showed abnormal signs in the left lower chest behind. In none of these cases was there evidence of any considerable amount of fluid in the pericardium, a fact confirmed in many by aspiration or at necropsy. The signs found included dullness of varying extent, bronchial breathing, and bronchophony. H. A. Christian (*Jour. Amer. Med. Assoc.*, Aug. 10, 1918).

Case of a woman, aged 32, suffering from pericardial effusion with paralysis of the left recurrent laryngeal nerve. Braun (*So. African Med. Rec.*, Sept. 27, 1924).

The rapidity of the process varies greatly. Sometimes a dry pericarditis lasts but few days; a rheumatic pericarditis may cause a rapid effusion of serofibrin, so that in forty-eight hours the sac will be much distended, and in other instances there is a gradual increase of fluid for several weeks.

Rheumatic cases usually pursue a favorable course, and seldom demand active interference. On the other hand, when the pericarditis complicates pleurisy, pneumonia, valvular disease of the heart, or chronic nephritis, life is in great danger.

In septic cases pus develops rapidly; death may ensue in three or four days.

Acute pericarditis is a secondary infection, with extension from adjacent structures uncommon, while the vast majority of infections are probably via the blood. The difficulty of diagnosis is illustrated by the fact that acute pericarditis was recognized clinically only 100 times in 34,467 cases and 12 times in 78 autopsies at the Boston City Hospital. Pneu-

monia is the chief agent in the production of purulent and of fatal pericarditis. *Pneumococcus pericarditis* or *myocarditis*, or both, should be considered, especially in young or middle-aged adults, when the heart shows failure of compensation before the crisis or after it when there is fever or delayed convalescence. The prognosis of acute pericarditis following acute arthritis is generally favorable to life. *Pneumococcus pericarditis* is grave at any stage. Tuberculous pericarditis is not common, and is usually a late involvement in an advanced case. Robey (*Amer. Jour. Med. Sci.*, Apr., 1917).

Tuberculous pericarditis is almost absolutely hopeless, although it may pursue a chronic course.

The writers observed a case of tuberculous pericarditis with much effusion in which the diagnosis was long dubious; pericardiotomy alone cleared up the case and has apparently cured the patient. This affection has no pathognomonic signs or symptoms; even puncture may prove misleading and do actual harm, while from the therapeutic point of view it is inadequate and has to be inevitably followed by pericardiotomy sooner or later. They advocate therefore **pericardiotomy** as the routine procedure. O. Jacob and Chavigny (*Revue de méd.*, July, 1911).

**DIAGNOSIS.**—From what has already been said it follows that in some instances pericarditis cannot be diagnosed, subjective and objective symptoms both failing. Other cases are self-evident. In a third class of cases we have the possibility of confusion with endocarditis; hypertrophy, or dilatation of the heart; myocarditis, and localized pleurisy.

The endocarditic murmurs are apt to be localized at places corresponding with the valves of the heart, and to be transmitted farther than friction

sounds. They are, moreover, synchronous with the heart's movements, and they usually have a softer, blowing, and distant character, which contrasts with the harsher sound, near the ear, of pericarditis.

The hypertrophied heart is usually easily distinguished from pericarditis; the impulse is vigorous, the heart sounds loud, and the outline of dullness is, although greater than in health, yet approximately normal in shape.

Certain cases of dilatation of the heart are perplexing, especially where the pericardial friction sound has been heard within a short time previous. The observer is obliged to consider carefully whether the enlargement of the cardiac area of dullness and the feebleness of the heart sounds are due to change in the heart wall or to an effusion outside of it.

In dilatation the heart sounds are clear, and the first sound of the heart may be, although valvular, quite strikingly distinct. The apex of the heart is never displaced upward by mere dilatation.

The cardiac impulse is often extensive in cases of dilatation, although giving the impression of feebleness and irritability, and the area of dullness is rather more quadrilateral than pyramidal, although, it must be confessed, too much reliance should not be placed on this distinction.

Even with large effusions the apex impulse may remain visible and palpable and the heart-sounds of good intensity throughout. At times a pericardial rub may persist along the left sternal border near the base of the heart. The cardiohepatic angle, as fluid accumulated, was found to be acute, by percussion as well as by teleröntgenograms and fluoroscopy, except in a few instances with a right

angle. The shape of the angle was practically unaffected by rising from recumbency. There is an early increase in the cardiac dullness, both to the right in the 3d and 4th interspaces and to the left beyond the apex; this was more marked in the erect posture. Important is an extension of the relative dullness upward in the 1st and 2d interspaces. An early filling of the pericardial culs-de-sac along the great vessels, as evidenced by increased width of dullness and of the shadow in recumbency, is one of the most important physical signs of effusion. If the dullness and shadow become narrower in the erect posture, fluid is indicated. Absence of visible cardiac pulsation has been repeatedly noted fluoroscopically in large effusions and has aided in differentiation from cardiac dilatation. R. S. Morris and C. F. Little (*Amer. Jour. Med. Sci.*, Nov., 1923).

A rough systolic murmur simulating that of pericarditis may be heard at the base in case of chlorosis, but usually the two diseases can be distinguished without difficulty.

Considerable stress in point of diagnosis has been laid upon the fact that pericardial murmurs become more distinct when the patient sits up in bed, but it should be borne in mind that similar changes are not infrequently demonstrable in the case of endocardial murmurs.

Diagnosis is difficult in those cases in which a friction murmur has never been detected. If, however, the patient's condition becomes threatening, and the possibility of a considerable effusion exists, it is a proper and comparatively safe measure to insert an hypodermic needle, with aseptic precautions, so as to see whether fluid can be obtained. Perhaps the best point to choose for this purpose is the fifth left intercostal space, an inch and a half from the edge of the

sternum. Shattuck, and also Strümpell, recommended the lower left part of the pericardial sac, a little way inward from the margin of dullness. Another place is the left costoxiphoid angle: a spot which is probably perfectly safe when there is a large effusion, but otherwise renders one liable to perforation of the liver and diaphragm. If a sharp-pointed needle is employed suction may be begun as soon as the point of the needle is engaged in the tissues, and the needle then pushed cautiously forward until fluid begins to run.

A disadvantage of the needle is that its point may scratch the surface of the heart as it moves in systole and diastole. The trocar and cannula are not open to this objection, and are, on the whole, preferable. Moreover, a cannula can be moved about in order to loosen any adhesions. If there is strong reason to feel that fluid has collected, more than one effort to find it should be made.

While it is important to avoid puncture of the heart itself, this has occurred repeatedly without special damage, and in only one recorded case has such an accident proved fatal. Sloan saved a moribund patient suffering from pericarditis by unexpectedly drawing 10 ounces of blood from the right ventricle.

Röntgenoscopy may be resorted to with advantage. It is claimed that the shadow of the heart proper can sometimes be seen in contrast to the surrounding effusion, and that if there is thickening of the pericardium, this can be made out. Cases of pericarditis calculosa are usually well shown. The X-ray may occasionally help in deciding the point of election for paracentesis.

The X-rays are of little value before 200 c.c. or more of fluid have accumulated. With greater amounts, widening of the mediastinal shadow, a bulging of this shadow upward and to the left, widening of the heart shadow, obliteration of the normal curves of the borders of the heart, extension of the mediastinal borders as more or less straight lines up to the clavicle, and a change in the contour of the heart shadow with change in the position of the patient, can be determined more accurately by the X-ray than by other means. When there is some fluid in the pleural space or consolidation in the lung, a correct diagnosis may be made when it is practically impossible by other means. F. M. Hodges (*Jour. of Radiol.*, Oct., 1923).

Case of tuberculous pericarditis with hemorrhagic effusion in which X-ray examination after removal of fluid and injection of 100 c.c. of air suggested the presence of adhesions as evidenced by a light area between the right edge of the heart and the pericardium. Upon further injection into the pericardium of 20 c.c. of lipiodol after withdrawal of 100 c.c. of the effusion, the acuteness of the cardiohepatic angle was found to be due to an extremely thickened parietal layer of the pericardium, no adhesions being present. Castex, Carelli and Gonzalez (*Bull. Soc. méd. des hôp. de Paris*, Feb. 12, 1926).

**ETIOLOGY.**—Pericarditis is never an idiopathic affection. It may be due to infectious germs, or to toxic conditions of the blood, or to inflammation extending from contiguous organs. It is very frequently associated with acute articular rheumatism, and it may precede the joint symptoms, especially in children. It may also complicate scarlet fever, measles, small-pox, and typhoid fever.

It sometimes occurs in diphtheria, and not so very seldom in association with pneumonia. Septic processes may give rise to it, such as acute

osteomyelitis, puerperal fever, and gonorrheal infection. It has been known to occur after tonsillitis and after influenza. Tuberculosis is a very important cause.

Its occasional development in cases of chorea brings to mind the mysterious association between rheumatism, chorea, and pericardial disease. Another important cause is chronic nephritis; according to Widai and Weill, the pericarditis attending this condition is a manifestation of marked nitrogen retention. Gout, scurvy, purpura hemorrhagica, leukemia, and cancer also deserve mention.

The disease attacks youth and middle life oftener than old age. Addiction to liquor increases the liability to pericarditis. Males are somewhat oftener attacked than females.

By extension from contiguous organs the disease is developed in pleurisy and pleuropneumonia, endocarditis, purulent myocarditis, aneurism of the aorta, and also from disease in the bronchial glands, the bones, the esophagus, and even the abdominal viscera.

**PATHOLOGY.**—The changes in the pericardium due to inflammation correspond closely to those seen in other serous membranes, particularly the pleura. The first change is an injection of the superficial blood-vessels, which may give the whole surface a dull-red color. Fibrinous exudation may consist either of a few stringy deposits, or a more uniform thin membrane, or, again, a thick, irregular coating. This coating may be ridgy, honey-combed, or shaggy. In chronic cases it may become of enormous thickness, and even present plates of cretaceous material.

In cases of serofibrinous exudation the amount of fluid varies between 200



or 300 c.c. and 2 liters. There is a record of the enormous quantity of 1 gallon. The fluid may be tinged with blood, especially in tuberculosis, cancer, and nephritis. Aged patients are apt to have sanguinolent fluid. Purulent exudations consist of a creamy or a thinner seropus; in some cases they are offensive: "ichorous."

In cases of rather long duration or great severity the myocardium is involved in the process to the depth of 2 or 3 mm., entailing an organic weakness which gravely affects the prognosis.

In case the patient survives the disease, permanent changes in the membrane remain behind. There may be small patches of cicatricial change, or a limited number of adhesions, or, again, the pericardial sac may be entirely obliterated, presenting the condition of chronic adhesive pericarditis.

The changes thus far enumerated relate to the inner surface of the pericardium; not infrequently the inflammatory process involves its outer surface as well, giving rise to pleuro-pericarditis and mediastinitis, and eventually binding the heart in an unnatural degree to surrounding parts. (See below: CHRONIC ADHESIVE PERICARDITIS.)

**PROGNOSIS.**—Acute fibrinous pericarditis is seldom fatal, and most cases of rheumatic origin recover. On the other hand, the disease is very often a terminal phenomenon in patients very ill with certain diseases, such as nephritis, pleuropneumonia, and sepsis.

Tuberculous pericarditis is almost invariably fatal. The rapid outpouring of a large amount of fluid is dangerous from its mechanical effect, and aspiration may then save life if promptly performed. Cases seem-

ingly desperate may recover, even without intervention.

**TREATMENT.**—Pericarditis is not at all a disease in which routine measures are demanded or justified. Some cases, both of the fibrinous and sero-fibrinous variety, may progress to recovery unaided. If there is precordial pain or troublesome palpitation, **dry cold** may be employed **over the heart**; it should be used at first tentatively. We may employ an **ice-bag** covered with flannel, or **Leiter's coil**.

Study of the influence of the use of the **ice-bag** over the precordium in 25 persons, all normal. There was a maximum fall of 10 beats in the heart rate at the end of 30 minutes. This bears out the empiric use of the ice-bag in pericarditis, endocarditis, etc. The greatest effectiveness of the measure would be achieved by its use in alternating  $\frac{1}{2}$  hour periods. R. L. Gilman and C. J. White (Jour. Amer. Med. Assoc., Sept. 1. 1923).

Pain may demand an **opiate**. A fair amount of sleep for the patient is imperative. For this purpose **sodium bromide** is useful and **paraldehyde** seems likewise suitable. Robust patients in an abrupt and stormy onset of the disease may be benefited by **leeches** applied over the heart; but venesection and such cardiac sedatives as aconite are to be avoided.

According to West, **opium** is an invaluable remedy in acute pericarditis. Small doses at frequent intervals, *e.g.*, 5 minims (0.3 c.c.) or so of **laudanum** every 4 hours, are sufficient. The restless, distressed patient becomes quiet, the pulse rate drops 20 beats or more, and the heart action becomes steadier and more sustained. Many acute rheumatic heart cases do better with opium than with any other drug.—Ed.

Some patients obtain more relief from **hot** than from cold applications. According to Ortnier, **hot compresses** also have a distinct curative action

and strengthen the heart. **Dry cupping** may likewise be useful.

Blisters are now little used, although some authorities believe that they hasten the absorption of effusion. Cantharides is contraindicated in nephritic cases. No internal remedies seem to have any specific effect either in preventing or curing the inflammation. However, in the rheumatic cases, the **salicylates** in fairly large doses should certainly be tried.

Absolute **rest** should be continued until the last trace of effusion and of friction rub has disappeared and the heart action is entirely normal.

If, as is likely to happen in the progress of the disease, the pulse becomes irregular, intermittent, and of low tension, resort must be had to **digitalis**. The use of **ammonia**, **strychnine** and **alcohol** may also be in order.

The bowels should be kept open by **salines**, and **potassium acetate** may be employed as a diuretic. Moderate amounts of easily digested nourishment should be given at brief intervals.

It has been stated that rheumatic cases almost always recover; this is true even when large effusions are developed, so that some delay in **paracentesis** is justifiable here; but in general it is better to be prompt in the removal of any large effusion. One purpose of this is to relieve the heart of mechanical embarrassment, and another is to discover the character of the effusion, for purulent pericarditis has a better chance of recovery if permanent drainage is early established. For other particulars with regard to aspiration see **DIAGNOSIS**.

Therapeutic **pneumopericardium** employed in a case of pericarditis with effusion on the plea (1) that the aid

after drainage would serve to keep apart the inflamed surfaces, thus preventing the formation of adhesions; (2) that relief would be obtained from the embarrassment of a voluminous exudate, while the air would temporarily maintain the pericardial distention and allow it gradually to contract as the air was absorbed; (3) that there would be delay in the reformation of the exudate, this being brought about by the tendency of the air to maintain the pressure that had been exerted by the fluid; (4) that in the case reported, the process being *tuberculous*, the air might have some effect in hastening the termination of the inflammation, a phenomenon observed at times in tuberculous peritonitis. The 1st paracentesis was done on Dec. 31, 1923; Jan. 4, the 2d; Jan. 8, the 3d; Jan. 18, the 4th; Feb. 1, the 5th. Each injection of air was followed by marked subjective and objective improvement. The patient was discharged Feb. 2. R. H. Oppenheimer (Jour. Amer. Med. Assoc., May 24, 1924).

Several surgeons have made independent studies of the best method for draining the pericardial sac. In a general way it may be said that an important point is to avoid opening the pleural cavity, which might cause pneumothorax or empyema.

The fourth (**Porter**), fourth and fifth (**Roberts**), or fifth and sixth (**Delorme**) costal cartilages near the sternum may be resected, the pleura and the internal mammary artery being drawn toward the left, and the pericardium thus exposed. Venus found that, of 300 cases of pericarditis in which the operative treatment had been resorted to in 197 instances, 72, or 40.45 per cent., were cured and 6, or 3.37 per cent., were improved. According to Venus, **puncture** is allowable only when there is no supuration, which can be determined by

an exploratory puncture. In case of suppuration, **resection of ribs** and **pericardiotomy** only can be considered. After pericardiotomy the pericardial cavity should be carefully rinsed with salt solution and extensively drained. (See also CHEST, INJURIES AND SURGICAL DISEASES OF THE, section on PERICARDITIS.)

In tuberculous pericarditis, with serofibrinous exudate, **heliotherapy** may be of considerable assistance (Lian and Corneau).

The safest place for **puncture** is the fifth or sixth intercostal space outside the left nipple line, but well within the area of dullness, for here, owing to the displacement of the heart upward and the distention of the pericardium outward, is the widest space between the heart and seat of puncture. All fluid obtainable should be removed. Often it does not reaccumulate, but if it should a second and third paracentesis may be performed, or as many as necessary. West (Lancet, Feb. 26, 1910).

**Puncture** of the pericardium becomes useful in pericarditis with effusion whenever the latter "tampons" the heart and cripples its action. The puncture is also made in effusion of blood into the sac. The operation is not to be undertaken except on the strictest indication on account of the danger of puncturing the heart itself. A puncture which is unwarranted usually results in a pericardiotomy. There is no typical puncture point, and many surgeons have their favorite localities. The fluid should be allowed to come away very deliberately, else the heart may collapse. Kolb (Berl. klin. Woch., June 3 and 10, 1913).

While careful investigation should always be made by percussion, auscultation and X-ray study before resorting to tapping or other surgical attacks, various researches and many war experiences in thoracic wounds, and the acknowledged innocuousness

of pericardial incisions, indicate that it may be at times not only wise, but imperative, to open the sac of the heart for diagnosis. J. B. Roberts (Arch. of Surg., Jan., 1923).

**Pericardiotomy** with drainage of the pericardium performed in 36 cases of pericarditis secondary to osteomyelitis. Recovery took place in only 2 instances. In both these cases the primary bone disease had been operated on at a comparatively early stage, and the pericardium was drained before the effusion had become purulent. It is a matter for serious consideration, from this experience, whether it is not advisable to perform early pericardiotomy in cases of osteomyelitis before the effusion becomes purulent. The evidence seems positive in this respect. R. Brooke (Lancet, Aug. 16, 1924).

The only treatment holding out any hope for cure in *purulent* pericarditis is surgical **incision** and **drainage**. Occasional recoveries follow in cases where the infection is limited to the pericardial sac. Early diagnosis of pericarditis with effusion, either serous or purulent, is the only factor that will lower the 60 per cent. mortality from pericardiotomy. Local abscesses in the heart-muscle are a possibility and, if operation is delayed, a probability in all purulent pericarditis. Hence, one has to deal with a weakened heart-muscle. All work done must be rapid and as shockless as possible. Anesthetics must be given with great caution. The procedure recommended is as follows: (1) Incision over the 5th or 6th costal cartilage about 2½ to 3 inches long, curved or straight as desired. (2) Strip back periosteum from cartilage. (3) Resect cartilage for adequate exposure and, if necessary, (4) ligate internal mammary artery above and below. (5) Retract the pleural overhang. (6) Incise and drain the exposed pericardium through the smallest possible nick, thus allowing a long time to elapse during the evacuation. (7) Investigate by palpation for any loculations or adhesions. (8) Drain. Whether or not

the pericardium should be sutured to the wound edge or skin for permanency of drainage will depend on the case; but, as a rule, this procedure is not practical. A rolled rubber dam, changed daily, may be used. In the authors' successfully operated case in a boy of 4½ years, with recovery, no drain was used, but postural drainage depended on; the child was kept on the left side, face down and feet elevated, empyema having preceded the pericarditis and the opening been made through the 3d costal cartilage. A. C. Wood and W. N. Bradley (Med. Jour. and Rec., May 6, 1925).

**CHRONIC ADHESIVE PERICARDITIS (EXTERNAL PERICARDITIS; PLEUROPERICARDITIS; MEDIASTINOPERICARDITIS).—**The obliteration of the pericardial sac may not embarrass the heart's action in any important degree. If, however, the adhesions are formed at a time when the heart is dilated, the heart cannot easily regain its normal size, and is apt to become incompetent. If the external surface of the pericardium, as well as the internal, forms unnatural adhesions, the condition is far more serious.

In adhesions between the pericardium and the diaphragm, the functional disturbance is a set of symptoms suggesting angina pectoris. The physical symptom is the disappearance of the apex beat. The X-ray shows a shadow at the left side where the heart and diaphragm are soldered together. This triad characterizes adhesive phrenopericarditis. The writers have encountered 20 cases of this kind. Although the angina pectoris symptoms may be distressing at times, yet they never had serious consequences. Trémolières and Caussade (Presse méd., Apr. 4, 1918).

Three types of adhesive pericarditis recognized: (1) External pericarditis or *accretio cordis*; (2) pericarditis plus epicarditis, or cardiac symphysis

proper; (3) internal epicarditis. As described by Rehn and Volhard, external symphysis hinders systole while internal symphysis obstructs diastole. Internal epicarditis has no special clinical signs but, as in a case reported, presents the usual evidences of cardiac symphysis; it is featured pathologically by inflammation of the inner layer of the pericardium, particularly on its internal (cardiac) aspect. In the author's case the epicardium was so thickened and fibrous as effectually to strangle the heart. Fluoroscopy had revealed absence of expansile cardiac pulsations. A Delorme-Rehn operation brought no improvement. Grossmann (Paris méd., Dec. 29, 1923).

**DIAGNOSIS.**—In many instances internal adhesions are not capable of demonstration, although they may be suspected if there is rapid heart-failure after an attack of pericarditis. External adhesions may cause abnormal motions of the thoracic walls. Systolic retraction of the thorax in the neighborhood of the apex beat is particularly characteristic; there may also be an epigastric retraction, and one at the seventh and eighth ribs near the left edge of the sternum. It has also been stated that laterally and posteriorly there may be a similar systolic depression at the base of the left chest. In some cases the *pulsus paradoxus* is produced, that is, the radial pulse becomes feebler or intermits with every inspiration. Broadbent's sign—systolic recession of the left lower ribs posteriorly—is not pathognomonic, as it may be definitely present in cardiac enlargement independent of pericardial disease.

The veins in the neck sometimes exhibit a diastolic collapse, being at other times overfull. Much value is placed upon the diastolic shock, or rebound, which may be felt on placing the hand over the heart's apex.

Other points are the wide extent of the cardiac dullness and of visible cardiac motion, and the fixity of the apex beat without regard to alteration of posture or respiratory influences.

Where the pericardial adhesions are very extensive, fluoroscopy may reveal the heart smaller than one would expect to find it, and apparently not contracting, the adhesions limiting and masking cardiac motion. The ascites which develops is often mistaken for that of atrophic cirrhosis of the liver. Volhard and Schmieden (Klin. Woch., Jan. 1, 1923).

The discovery of this condition is valuable mainly as a means of prognosis, the treatment being seldom satisfactory. The embarrassed heart may be stopped in a sudden fatal syncope, or go through the more gradual changes of broken compensation. Sometimes chronic mediastinitis extends through the diaphragm, in children, and gives rise to perihepatitis, perisplenitis, and chronic ascites.

Case of *pericarditis calculosa* or contraction of the pericardium exhibiting the group of signs outlined by Volhard, viz., heart weakness, venous stasis, ascites and fullness of the veins of the neck even in the erect position and with the arms raised—evidences of inhibition of diastole through obliteration of the pericardial cavity, whereas mediastinopericarditis hinders systole. X-ray examination had not revealed the calcium incrustation, which was found at operation. **Pericardiectomy** was followed by marked improvement. Kirschner and Matthes (Deut. med. Woch., Feb. 5, 1926).

**Pick's Disease.**—Pick's disease or syndrome—also known as *chronic multiple serositis, polyorrhomenitis, or pericarditic pseudo-cirrhosis of the liver*—is characterized by enlargement of the liver with obstinately recurring ascites, but no jaundice, in a patient with a history of, or with coexisting or subsequent pericarditis. The pericardium

may become adherent and its sac obliterated. Various serous membranes may become involved simultaneously or in close succession, and the liver and spleen (likewise enlarged) typically develop a fibrous superficial thickening which presents the appearance of sugar icing. Evidences of chronic peritonitis may be present, and chronic pleuritis frequently coexists.

The disorder may occur in children as well as adults. No definite cause is known, but a toxic origin is suspected, and some cases are tuberculous. The condition may be symptomless for years, and has often been merely an autopsy finding. Ascites is the chief symptom, though a feeling of fullness in the upper abdomen may have preceded it. There may be a transient edema of the legs. The syndrome is distinguished from tuberculous peritonitis by the absence of fever and of other evidences of tuberculosis. It is never recovered from, but life generally continues for a number of years, with progressive heart weakness or intercurrent disease, especially pneumonia, usually inducing the fatal termination. The treatment consists of frequent tapplings of the abdomen and, in some instances, pleural tapplings. Surgical intervention has not proven advantageous.

**TREATMENT.**—Injections of **fibrolysin** or **iodolysin** may be tried. **Thiosinamine** has been recommended for dyspnea by Rénon in daily dose of 0.06 to 0.10 Gm. (1 to 1½ grains), either by injection or ingestion. It is contraindicated, however, in the tuberculous.

In some cases **Brauer's operation of cardiolysis** has given marked relief. The operation should be performed during a quiescent period and not when an exacerbation of heart-failure is present. This renders the use of an anesthetic possible. The operation should not be done in the presence of a polyserositis. Marked improvement was obtained in 75 per cent. of 38 cases.

In the **Delorme-Rehn operation** of

**pericardiolysis** or **pericardiectomy**, Brauer's cardiolysis is supplemented by decortication of the heart for relief from the internal form of fibrous pericardial thickening. The operation is less frequently successful than is cardiolysis in the cases of external thickening.

**Cardiolysis**, the removal of sections of the ribs which imprison the heart, in cases of extensive, adhesive medias-tinopericarditis, was first performed at the suggestion of Brauer, in 1902. The best time to operate is when the apex tug, and the diastolic shock, and Broadbent's sign are strikingly characteristic, because these symptoms indicate the struggle of a strong heart muscle. These signs fade as the tone of the heart muscle weakens; they are the indices for prompt operation. In order that a soft, movable, musculo-cutaneous covering of the heart may take the place of the bony chest wall, it is advisable in removing the ribs, that all their periosteal covering should go. Any pleural wounds are sutured after temporary occlusion with gauze sponges. The heart muscle in both cases reported by the author, was in an advanced degenerated condition, almost hopelessly so. Notwithstanding this, 1 patient, a man, lived 4 years and 10 months; was able during this period to earn his living, and was almost free from heart symptoms until the last several months of his life. The second patient lived nearly a year after operation. J. E. Summers (*Surg., Gynec. and Obstet.*, xxv, p. 92, 1917).

In **cardiolysis**, a horseshoe-shaped incision is made, with its convexity downward, a flap of the soft tissues turned up, and portions of the 3d, 4th and 5th costal arches removed with their anterior periosteum. The posterior periosteum is left, for the risk of new bone formation is slight; moreover, an attempt to strip it from the firm fibrous adhesions that lie behind may result in danger to the pleura and even to the cardiac muscle.

Indications for cardiolysis are adherent pericardium where the rheumatic infection seems arrested, latent, or only slowly progressive and where signs and symptoms of heart failure are present. Of 23 cases in the literature and 2 personal cases, 17 were rheumatic, 3 probably rheumatic, 2 tuberculous, 2 probably tuberculous and 1 indefinite. Thirteen cases with edema and ascites were greatly improved by the operation for 3 months to 5 years; 4 cases showing earlier signs of heart-failure were definitely improved, and 4 only slightly; 1 was not improved, and 2 died 12 hours and 20 days, respectively, after operation. Geoffrey Bourne (*Quart. Jour. of Med.*, Jan., 1924).

Cardiolysis should be kept in mind by internists and surgeons as a very valuable measure, although the authors' case appears to be only the 6th reported in the United States. The patient was a woman aged 26, with cardiac contractions shaking the entire body, inability to lie on the left side, slight precordial pain, and a history of rheumatic fever at 17. The left anterior chest showed a distinct prominence. The transverse diameter of the heart appeared on the roentgenogram as 17 cm. **Cardiolysis** was performed under local and block 0.5 per cent. **procaine** anesthesia, each intercostal nerve being blocked posterior to the area of rib to be excised. Through a curvilinear incision, with division of the pectoral fascia and origin of the pectoralis major, and upward retraction of a flap including the breast, subperiosteal resections of the 4th, 5th and 6th ribs and their cartilages were carried out from just beyond the mid-clavicular line to the sternum. Three cm. of periosteum over the 5th and 6th ribs was removed, and the wound closed in layers. On the 3d day the patient could already lie on her left side. Eleven months later she was vastly improved, and could do all her housework and walk considerable distances. H. M. Marvin and S. C. Harvey (*Jour. Amer. Med. Assoc.*, May 10, 1924).

As emphasized by Pitt, prophylactic treatment is most important. Much more might be done to prevent acute rheumatism from developing in children, by keeping the nasopharynx in a healthy condition and insisting that they should be instructed at school in nasal breathing. The majority of cases owe their origin to mouth breathing, and are very often associated with adenoids; but too often, when the adenoids have been removed, no instructions have been given about the training necessary to prevent their recurrence. Acute pericarditis is the most grave cardiac lesion of childhood. All patients with rheumatism should be put to bed as soon as possible and, if acute pericarditis develops, very prolonged rest in bed is necessary, when possible for at least six months, because if the heart's work is reduced to a minimum the heart is less likely to dilate, the adhesions will be less extensive, more supple, and more likely to be absorbed than when the child runs about and takes exercise.

**HYDROPERICARDIUM.** — In dropsy of the pericardial sac it is usual to find *post mortem* a teaspoonful or two of serous fluid in the pericardium, which probably transudes after death. Larger quantities may form during life as a result of chronic heart disease, emphysema, and more often chronic nephritis. In these cases there is no friction sound nor other evidence of inflammatory change. The symptoms are usually merely those of the causative condition, although, of course, a large amount of fluid may add to the embarrassment of the heart.

The prognosis and treatment are directed to the underlying disease, and it is rarely necessary to aspirate.

**HEMOPERICARDIUM.** — Blood in the pericardial sac is a rare condition which may be caused by aneurism of the aorta, aneurism of the coronary arteries, and by trauma.

Death occurs usually much too rapidly to permit any treatment, and diagnosis is rarely possible. In a few traumatic cases **aspiration** has been successfully carried out.

Case of a little girl who fell and drove half of a needle through her chest wall into the pericardial sac, with the production of an infected hemopericardium. This was aspirated twice with some relief, but it was deemed best to do an open operation. This was done over the base of the heart, removing the second, third, and fourth costal cartilages, and through the wound 300 c.c. of blood-stained fluid was allowed to escape. The point of the needle was to be felt projecting within the pericardium and it was removed from within. The wound was closed with a drain and so far as the surgical phase of the case was concerned all went favorably. Bronchopneumonia developed fourteen days after the operation and resulted fatally two weeks later. Gunson (*Lancet*, June 8, 1912).

**PNEUMOPERICARDIUM.** — Air in the pericardial sac may be caused by perforating glands, and by the perforation of some lesion in the lungs, esophagus, or stomach.

There is almost always a purulent exudation present in addition to the gas; rarely, there may be merely a serofibrinous fluid.

The auscultatory signs of such a condition are striking: the sounds take on a metallic character, and there may be a splashing audible even at a distance. The areas of tympany and of dullness, respectively, will be changed by altering the patient's posture.

**Treatment.**—Treatment is the same as for a severe attack of ordinary pericarditis. The prognosis is extremely grave. The air has been successfully removed by **aspiration** in a few cases. Surgical measures may be resorted to in some cases to close the pericardial wound.

Pneumopericardium may follow: (1) Spontaneous gas production from infected fluid in the pericardium; (2) traumatic perforation; (3) perforation from or into a neighboring organ; (4) artificial injection of gas. Aside from a possible attack of sudden dyspnea and sharp precordial pain, all the symptoms depend on the individual condition. The physical signs are almost unmistakable. Apart from the tympany, there is usually a splashing, gurgling or churning sound synchronous with the heart beat. There may be a metallic tinkle or metallic rub. Pneumomediastinum is differentiated by coexisting emphysema of the neck, lack of symptoms, absence of change in the heart sounds, and a precordial tympany which does not shift on change of position. The X-ray picture of pneumopericardium shows a clear, gas-filled space about the cardiac shadow, surrounded by a narrow band of pericardium, with a fluid level in the lower portion of the pericardial sac. In the author's case, one of tuberculous pericarditis with effusion, air had been injected into the pericardium in mistake for artificial pneumothorax. The therapeutic application of **injections of oxygen** into the pericardial sac was then tried, and the end-result was adhesive pericarditis. L. G. Rigler (Jour. Amer. Med. Assoc., Feb. 14, 1925).

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**HEART, DEGENERATIVE DISORDERS OF THE.—DEFINITION.**—Degenerative disorders of the heart, to which the term "**fatty heart**," has been applied, comprise

two pathologically distinct affections: *Fatty degeneration*, in which there occurs a transformation of the cardiac muscle-fibers into fat; and *fatty overgrowth*, in which an abnormal quantity of fat is deposited in, or about, the heart. They include also the conditions known as *brown atrophy*, *calcareous degeneration*, *amyloid degeneration*, and *hyaline degeneration*.

### FATTY DEGENERATION.

**DEFINITION.**—By the term fatty degeneration is meant the conversion of the cardiac muscle-fibers into fat.

**SYMPTOMS.**—The condition may exist in an advanced form without the production of symptoms (latent fatty heart). The presence of any causal conditions, however, should be noted, and they afford premises for suspicions, although even when symptoms during life point strongly to fatty heart it may not be found at autopsy.

The characteristic evidence of defective heart power is generally present, but in pernicious anemia, chlorosis, and in certain wasting affections the fatty change may be marked, the pulse continuing full and regular while the patient is at rest. In such cases slight provocation or strong excitement leads to palpitation, leaving signs of commencing dilatation (an apical systolic murmur, with feeble, diffuse impulse). The condition is quite commonly associated with hypertrophy and chronic nephritis; it then gives rise to the phenomena that characterize failing compensation. The process is constantly associated with sclerosis of the coronaries. I have frequently observed that these cases manifest the same grouping of symptoms as is met with in premature senility.



Dilatation is apt to supervene early in fatty degeneration of the heart, owing to the weakened state of the cardiac walls; hence it is quite probable that many of the symptoms that have been ascribed to the morbid processes are, in reality, due to secondary dilatation. It is to be remembered that the symptoms pointing clearly to defective heart power may be in evidence only after great exertion.

A sustained pulse at once negatives advanced fatty degeneration. The evidence yielded by the heart sounds is likewise ambiguous except when their loudness negatives the condition. Relative distance from the ear, thick parietes, intervening fluid or tissue, and particularly lung tissue, will effectually mask a good second sound, which sometimes then may be best heard in the neck. The first sound may likewise be partly extinguished. Greater significance attaches to the shortening of the interval between the first and the second sound, the ventricle "not going through" with its systole, though this too is just as much a constant result of mere heart fatigue or asthenia. Slowness of the pulse, though a specially common symptom, cannot be strictly identified with the affection. No physical signs whatever are obtainable from palpation and percussion of the cardiac area. We are, practically speaking, left without a single positively identifying mark. And yet the diagnosis has to be made, and is often enough made, from the general clinical aspect of the case, and from the aspect of the patient, which taken together seldom deceive the experienced physician. Sir William Broadbent (*Lancet*, May 27, 1905).

Among the symptoms pointing to overdistention, either constant or temporary, of the cardiac chambers, are palpitation, dyspnea, and a small,

irregular, somewhat quickened pulse, and cool and clammy extremities. Great physical exertion may produce sudden, marked dilatation, whereupon a canter rhythm and an apical systolic murmur speedily develop, although in most instances the symptoms are brought to light in a more gradual manner.

Breathlessness on exertion, even though slight, and syncopal attacks are sometimes troublesome. There may be frequent attacks of cardiac asthma in the morning, and these may be accompanied at intervals by pains, anginoid in character, even assuming the severity of true angina. The latter complication may, however, occur independently of the asthmatic seizures. The pulse, in consequence of the irritation of the inhibitory center in the medulla, frequently becomes much retarded, declining from the normal rate to 30 or 40 beats per minute, and in rare cases to 10 or 12 beats. Disturbances of the intellect, at times assuming the form of maniacal delusions, may come on and persist for weeks and even months. The fatty *arcus senilis* possesses no diagnostic value.

Two symptoms of considerable value, particularly when combined in the same case, are pseudoapoplectic attacks, due to disturbance of the cerebral circulation, and Cheyne-Stokes respiration, the latter being among the later manifestations. When Cheyne-Stokes breathing is in association with pseudoapoplectic seizures, they are more apt to be due to a uremic toxemia, perhaps, than to fatty degeneration of the heart. According to Broadbent, a noteworthy point is that well-marked dropsy is rare, and probably never occurs in uncompli-

cated degeneration. The significance of this is that the special effect of the disease is defective pressure in the arterial system, and it is to this that the syncopal, apoplectic, and epileptiform attacks, as well as those of angina pectoris, are due. The syncopal attacks vary in severity, are marked rather by duration than intensity, and are not attended with complete loss of consciousness. He also mentioned attacks resembling *petit mal*, attended with slow pulse.

As to physical signs, there is a weak, irregular impulse that often can neither be seen nor felt; later dilatation supervenes. After the latter event the impulse is apt to be diffuse. The most constant and significant feature of the pulse is that it is short and unsustained (Broadbent). The area of cardiac dullness increases, and a soft systolic murmur is often audible at the apex (relative insufficiency). When fatty degeneration is associated with marked obesity, it is difficult to delimit the area of dullness, for obvious reasons, and the cardiac sounds on auscultation are apt to be weak, distant, and muffled. On the other hand, in thin subjects and in the fatty degeneration of grave anemias, the first sound of the heart is often short, sharp (flapping in character), simulating the second sound.

The most characteristic symptoms associated with fatty degeneration of the heart are those of general debility and feebleness, more or less languor and somnolence, as a rule without marked cardiorespiratory symptoms except shortness of breath on exertion. The pulse is usually small, rather collapsing and feeble, the blood-pressure is below normal, and the pulse-rate is increased. The tone of the cardiac muscle is diminished. None of the symptoms is either constant or charac-

teristic, and the diagnosis may have to be made by inference only. Patients with fatty degeneration of the heart are very sensitive to digitalis. Sudden death from overdose of this drug or from acute cardiac overstrain is relatively common in patients with fatty degeneration. The causes of fatty degeneration of the heart include alcoholism and primary or secondary anemia. It may be associated with myocarditis, valvular or other cardiac lesions, and may occur in most infectious diseases, in miners, smelters and in workers in various metals. A. D. Hirschfelder ("Diseases of the Heart and Aorta," p. 312, 1918).

**DIAGNOSIS.**—The diagnosis is unfortunately obscure. In a large number of cases the patient has not consulted his physician when sudden death supervenes from rupture, usually during active exertion or excitement; less frequently the termination in death follows the administration of an anesthetic or a full meal. Rarely, death follows the action of the exciting cause after the lapse of several hours.

While fatty degeneration may be a sequel of coronary disease, sudden death in the latter is in the majority of instances to be ascribed to the changes in the arterial coats rather than to fatty degeneration of the heart walls with ensuing rupture. Corroborative post-mortem evidence is not wanting. Key Aberg found extensive areas of fatty degeneration only in 2 instances out of 13 autopsies of sudden death from cardiac paralysis brought about by sclerosis of the coronary arteries.

The history, particularly if this points to the existence of arteriosclerosis, the age of the patient, the symptoms of cardiac weakness and subsequent dilatation coupled with retardation of the pulse (though the

latter may be increased in frequency), apoplectic attacks, the Cheyne-Stokes respiration in the absence of antecedent hypertrophy, may be regarded as significant features. Again, with a clear history of the presence of the more characteristic symptoms, including the signs of dilatation following hypertrophy, fatty degeneration may be inferred with some degree of assurance, and yet even this state of affairs should not lead to a positive statement of opinion.

In persons having reached middle life in whom a weak and irregular action of the heart is manifested, it becomes an important question to decide whether this be due to functional disturbances or organic disease. Broadbent found that usually this is accomplished by making the patient walk briskly. A few steps will often be sufficient. If the heart is sound it rises to the occasion. The pulse and beat sounds are all more distinct, and strong and regular, whereas the fatty heart "goes to pieces," and the pulse becomes irregular and shorter than ever or may even disappear.

Fatty degeneration may follow fatty infiltration of the heart, and while in consequence of this fact the two conditions are sometimes found in association, they are to be looked upon as separate and distinct morbid processes.

Rosenfeld and others have shown that in fatty changes of the type ordinarily designated as fatty degeneration the fat contained in the degenerated cells was a true infiltration from outside the cells. The writers found that dogs fed upon lean horseflesh and mutton tallow had deposited in the fat depots of the body a fat very similar in composition to the fat of sheep. If in such dogs a "fatty degeneration" of

the myocardium was produced by phosphorus poisoning, the fat in the myocardium was found to be of the same composition as that in the rest of the body—that it, like mutton fat. If the fat were produced by a transformation of the muscle cytoplasm into fat it certainly would not be of a foreign type, like sheep's fat, and the only possible conclusion is that the fat was obtained by transference from the fat depots. Leick and Winckler (*Archiv f. exp. Path. u. Pharm.*, Bd. xlviii, 1902).

In attempting to discriminate one from the other a recognition of the differences in causation is all-important. Fatty overgrowth (see next heading) is due to and associated with polysarcia, while the leading causal factor of fatty degeneration of the heart is arteriosclerosis affecting the coronaries, or atheromatous changes in the valves or walls of the aorta, causing obstruction at the mouths of the coronaries: conditions that would lead to weakness of the cardiac walls due to degenerative change. Among favoring causes of fatty degeneration are to be reckoned all the various factors that tend to bring about arteriosclerosis, as syphilis, diabetes, and alcoholic excess, though the latter may also act primarily upon the myocardium or the blood itself. Cases of fatty heart occur independently of coronary disease. Thus, the disease coexists with pernicious anemia, chronic alcoholism, and not infrequently follows acute forms of disease, as acute aortitis and typhoid fever. In typical arsenical and phosphorus poisoning the fatty heart is constantly encountered.

The symptomatology of these two cardiac affections presents differences of considerable significance. Both may exist, however, without the pro-

duction of symptoms, and both have symptoms in common, such, for example, as dyspnea upon exertion, and arrhythmia, including reduplication. In fatty degeneration the volume of the pulse is diminished to a greater extent, and the disturbance of the pulse is also greater than in fatty infiltration. The breathlessness of fatty infiltration after exertion is associated with obesity; not so in fatty degeneration, as a rule.

The occurrence of "syncopal, apoplectiform, and epileptiform attacks" in connection with the factors of etiological importance mentioned above, points strongly to fat-degeneration, and these symptoms are attributable to insufficient pressure in the arterial tree. Mild syncopal attacks may arise in fatty overgrowth, but when they become more severe, more frequent and prolonged, and particularly with associated coldness and clamminess of the extremities and body surface, then fatty degeneration should be suspected. Much the same remarks apply to the symptom angina.

The symptoms of bronchitis and asthma, either separately or combined, are oftener met in fatty overgrowth. In the latter condition the heart sounds are weak and distant or muffled, owing to abnormal fat deposits; in fatty degeneration the sounds are short, flapping in character, due to associated dilatation, but they are clear, and an apical systolic murmur is not uncommonly audible.

The so-called therapeutic test is an aid in the discrimination. Thus, as the result of appropriate treatment for the obesity the abnormal deposits of fat in and around the heart can be made to disappear gradually, with marked or even complete relief from

the inconveniences occasioned thereby. On the other hand, slight temporary improvement, if any, is all that can be hoped for in advanced fatty degeneration, or at a time when the diagnosis is reasonably assured.

Finally, it may be said that the recognition of fatty infiltration is an easy matter, while that of fatty degeneration is scarcely possible until a late stage is reached. That form of fatty degeneration which follows compensatory hypertrophy is distinguished from fatty overgrowth by the special history, absence of obesity, and obviously dissimilar physical signs. It is to be recollected that dilatation following hypertrophy is not invariably due to fatty change.

**ETIOLOGY.**—Fatty degeneration may supervene in both secondary and primary forms of hypertrophy, as well as in chronic myocarditis and chronic pericarditis. The degeneration of the cardiac walls dependent upon valvular disease, Bright's disease, and general arteriosclerosis is, perhaps, more often fibroid than fatty in nature.

It is constantly met, also, in association with fatty change in other organs, in the severe forms of primary and secondary anemias, and even more commonly, though of a less severe grade, in the cachectic states produced by such chronic diseases as carcinoma and phthisis.

Recent observations have shown that fat is more widely distributed in the tissue cells than was formerly taught. In addition to the liver, intestine, suprarenals, and subcutaneous tissues, a number of the glandular organs contain a certain amount of fat as the expression of physiological activity, *e.g.*, salivary glands and pancreas, kidneys, testicles and

ovaries, thyroid and pituitary, the sweat-glands, spleen and thymus, muscles, and nervous system. When fat circulates freely in the bloodstream,—in contrast with the normal small amount,—as in the condition of lipemia, the connective tissues and parenchyma of the liver, heart, lung, spleen, kidney, and testis, all contain globules of fat, although no degenerative changes can be demonstrated. Herxheimer and Walker Hall (Med. Chronicle, Aug., 1904).

Alimentary fatty heart is equivalent to the fatty infiltration of the normal heart. Some authors attach no clinical significance to this phenomenon. The heart, fatty or not, can go ahead up to the point of death without functional insufficiency. Nevertheless no one regards such a heart as normal, although the fetal heart regularly passes through this cycle. Wegelin (Berlin. klin. Woch., Nov. 17, 1913).

The condition may arise in the course of acute infectious diseases of intense type, especially diphtheria and typhoid fever.

Certain toxic agents (arsenic, phosphorus, alcohol) are potent to cause a high grade of fatty degeneration. In the case of alcohol, it is only after long periods of intemperance that cardiac degeneration is established, and often only after primary coronary sclerosis. Besides sclerosis, which is an all-important etiological factor, the condition may be consequent upon a mere blocking of the mouths of these vessels.

Fatty degeneration is most common after forty years of age.

It occurs somewhat more frequently in men than in women, notwithstanding the fact that there are predisposing influences at work in the latter that do not obtain in the male sex, such as childbirth and amenorrhea. What-

ever may be its apparent etiology, it is invariably preceded by a defective nutritive supply to the muscle-cells; this may be dependent on mechanical causes, such as contraction of the lumen of the coronary vessels, or upon impairment of the oxygen-carrying power of the blood, as in the anemias, primary and secondary.

**PATHOLOGY.**—The process may be either general or localized. Thus, when circumscribed it may be limited to the uppermost or subpericardial layers, as when induced by pericarditis. The same minute foci and yellowish striæ may be observed in the superficial subendocardial layers, especially in the trabeculæ of the papillary muscles ("tabby-cat" striation). Blocking of one of the branches of the coronary artery (as a rule, the anterior) by a thrombus or embolus leads to the production of an anemic necrosis or white infarct, which is often composed of fatty *débris*.

In general fatty degeneration the muscular substance throughout presents a pale- or a light- yellowish appearance, and is quite friable, the finger being readily thrust into it. Rarely, the color-tint is brownish in circumscribed areas from associated brown atrophy.

In the heart may be found, in cases of long-standing anemia, chronic infection, intoxication, or disturbances of the coronary circulation, especially in the inner layers of its muscle, a yellowish pallor which, on close inspection, is found to be due to innumerable minute streaks and patches of opaque yellow, which shine through the endocardium and give the checkered appearance known as "tigering" or the "faded-leaf appearance." According to Ribbert, the patches correspond with minute irregularities in the distribution of the capillary blood-supply and

are produced by local anemia. Microscopically, the patches show heart muscle fibers in which myriads of minute globules, ranged in transverse and longitudinal rows, lie in the sarco-plasmic discs.

Virchow's idea that fat might be produced from the protoplasm of the cells, when the condition was to be spoken of as fatty degeneration (as opposed to fatty infiltration of normal cells by fat from elsewhere), held sway for many years. But Rosenfeld showed that the liver cells received fat from distant depots when an animal was poisoned with phosphorus. Further, an organ with abundant fat-globules in the cells need contain no more fat on chemical analysis than one which shows none microscopically. The following explanation of the appearance of fat in the tissue cell is offered: A normal amount of fat may be brought to a cell which is injured, and therefore incapable of using up its fat with normal rapidity. Impaired circulation, impaired oxygen supply from general anemia, or toxic injury to the cell in the course of infection, are among the possible causes of this condition. Fat accumulates, then, because it is not properly consumed. Again, injury of many types might disintegrate the physical or chemical combinations of lipoids existing in invisible form in the cells, and thus make the lipoids visible as such in the cell-body. W. G. MacCallum ("A Text-book of Pathology," pp. 83-85, 1920).

The various chambers of the heart are often enormously dilated with marked overstretching of the intra-cardial orifices. Coronary-artery diseases and atheroma of the arch of the aorta are among the most constant associated lesions.

In fatty degeneration the sarcous substance of the fasciculi is directly converted into globular fat, as contrasted with the condition of fatty infiltration, where the fat is deposited between the fasciculi.

Microscopically, the cell-fibers are observed to be displaced by minute granules and oil-globules, the latter first making their appearance at the poles of the muscle-nuclei; the striæ and nuclei become indistinct, and finally are wholly lost. The characteristic brown granules of brown atrophy may sometimes be visible, either at the extremities of the nuclei or uniformly distributed. The microscopic appearance of fatty degenerated muscular tissue is sometimes confounded with albuminoid degeneration, but the former may be distinguished by the characteristic brown coloration when stained with osmic acid, and also the fact that on treating a section with acetic acid the fat-globules are not thus affected, while the albuminoid granules are dissolved.

The pathologic diagnosis of fatty degeneration of the heart is made too frequently. While 12 patients with myocardial or valvular disease or both, dying with the classic symptoms of cardiac failure, all showed fat droplets in large quantities in the muscle cells in the classically described positions for fatty degeneration, *viz.*, in longitudinal and transverse rows between the fibrillæ, 13 normal hearts from persons who had met sudden, violent death showed the same fat droplets in the cardiac muscle cells. Bullard had already noted microscopically demonstrable fat between the fibrillæ in the normal heart tissue of over 200 animals of various species. Visible fat within the muscle cells does not stamp a heart as demonstrating fatty degeneration.

Clinically, fatty degeneration of the heart is a very uncertain diagnosis. The diagnosis should be based on etiologic grounds, *e.g.*, in phosphorus poisoning, pernicious anemia, etc. Fatty and fibrous changes should not be differentiated clinically. Apparently, the amount of fat in the heart muscle cells has no relation to the

state of nutrition at the time of death; neither has the age (8 to 56 years), color or sex.

True fatty degeneration, *viz.*, the "tiger heart," is recognized by the greater number and size of the fat granules and the evidence of inflammation, *e.g.*, nuclear changes, disappearance of striations, etc. While fatty degeneration is quite rare in the hearts of those dying from cardiac disease, *localized* areas of fatty degeneration in the heart muscle are not so uncommon. One of the writer's 12 pathologic hearts yielded this finding. The anterior descending branch of the left coronary was occluded by an old thrombus. Microscopic study revealed necrotic areas in the septum, and adjacent portions showed marked fatty degeneration in sections stained with scharlach R. The lateral wall of the left ventricle also showed areas of fibrous replacement together with fatty degeneration.

The so-called pigment of brown atrophy, located at the poles of the nucleus and supposed to be an indication of senility of the muscle, was stained yellow to golden-brown with scharlach R and light brown with osmic acid. These pigment granules are coarser than the fat droplets. They were found in moderate amounts in the hearts of 2 healthy boys. A. M. Master (Arch. of Int. Med., Feb., 1923).

**PROGNOSIS.**—This varies in a measure with the causative disorder, but, as a rule, the more corpulent the subject, the graver the prognosis. The increasing liability to sudden death must be borne in mind, the morbid process being commonly associated with sclerosis of the coronaries. In the majority of instances, however, the end is reached in a gradual manner, the signs and symptoms of advanced dilatation closing the scene. The frequent recurrence of syncopal, pseudoapoplectic, epileptiform, and anginal attacks heralds an

early fatal termination. All known remedies are without avail in restoring the integrity of the degenerated muscle-tissue.

**TREATMENT.**—The cause in each individual case should be determined with precision if possible, and, if detectable, a bold attempt should be made to remove or moderate it. This course embraces in different cases many hygienic and dietetic considerations that assist in improving the nutrition of the cardiac tissue: one of the cardinal aims of a proper system of treatment.

Anemia in one form or other often plays an important etiological rôle, and the particular variety present in each case must decide the character of the special remedies to be employed. Thus, pernicious anemia would call for the exhibition of **arsenic** in gradually ascending doses to the limit of gastric tolerance; *chlorosis* would demand, in addition to an appropriate hygienic regimen, the use of **iron** (*e.g.*, Bland's pills). In that large category of cases occurring in certain *cachexias* (cancerous or tuberculous) the following formula has, in my hands, given gratifying results:—

℞ *Arseni trioxidi* .... gr. j (0.065 Gm.).  
*Ferri sulph.* ..... gr. xxx (2.00 Gm.).  
*Strychnina sulph.* . gr. j (0.065 Gm.).  
*Quinina sulph.* .... 5j (4.00 Gm.).  
*Papoid* ..... gr. xxx (2.00 Gm.).

M. et ft. capsulæ no. xxx.

Sig.: One after mealtime.

When the signs of *cardiac dilatation* become well established, **rest** in the recumbent posture should be strictly enjoined, owing to the danger of a sudden fatal rupture of the heart, and cardiac stimulants should be administered. **Digitalis** and **strophanthus** may be selected, but should be pre-

scribed with some caution, the commencing dose being small, and increased according to the effect in the individual case. In the form of a powder or an aqueous extract it may be conveniently combined with the prescription appended above.

For sudden *heart-failure* the diffusible stimulants (**ether**, **ammonia**, and **alcohol**) are to be resorted to. If marked *arteriosclerosis* be associated, then **nitroglycerin** and the **nitrites** are to be employed.

In cases of average severity I believe that **gentle indulgence in physical exercise** and **light gymnastics** is beneficial, since it tends to invigorate the heart-muscle; it is to be increased in proportion to the improvement manifested in the patient's condition. Walking up ascents, however slight, is not to be advised for some time after the other, gentler methodic exercise has been commenced.

The benefits of **active gymnastics** in cases of fatty heart and allied conditions are due in part to the training of the muscles of the skeleton and vessels, but mainly to the sweeping away of obstacles accumulated at the periphery, and in some measure to reduction in the viscosity of the blood. Hasebroek (Deut. Archiv f. klin. Med., Bd. xciv, Nu. 1-2, 1908).

It sometimes happens, however, that even slight exertion is badly borne, and it should then be promptly discontinued. In the latter class of cases I have been in the habit of advising daily inhalations of **oxygen**, combined with complete **rest** and **recumbency**, with excellent results. Recourse to **massage** is also in the line of sound practice, but the sitting should not exceed half an hour in duration to begin with.

The more prominent symptoms may require special medication. Attacks of *syncope* are most successfully controlled by the hypodermic use of the diffusible stimulants (**ammonia** or **ether**), at the same time enjoining **absolute rest**, with the head lowered. For the *angina pectoris*, the combined use, hypodermically, of **morphine** (in small doses) and **atropine** is to be preferred, except in cases in which the apoplecticiform seizures, with a comatose tendency, are of frequent occurrence. Again, when the anginoid paroxysms are dependent upon coronary disease, recourse should be had to **nitroglycerin** and the **nitrites**. For the apoplectic attacks **rest** in the **recumbent** posture, with the head slightly elevated, is useful. Among therapeutic agents, **digitalis**, **ammonia**, and **ether** may be used hypodermically to stimulate the heart; it is also good practice to resort to **venesection**, withdrawing from 12 to 24 ounces of blood directly from a vein.

A strictly **horizontal position** and the application of **ice over the heart** often quickly terminates an attack of *asthma*.

The life of the sufferer may be prolonged by giving him an abundance of **sunshine** and **fresh air** in favorable weather, but exposure to severe cold must be scrupulously avoided.

The *diet* should be simple, easily assimilable, though highly nutritious. I believe it to be an excellent rule to allow **small meals** at strictly regular, **brief intervals**.

As described by Huchard and Fiessinger, degeneration may be very favorably influenced by a system of **diet regulation**. **Dechloridation** is deemed necessary; consequently the following regimen is prescribed: Breakfast: cold, lean meat, from 2 to 4 ounces (60 to 120 Gm.); saltless bread, 2½



drams (10 Gm.); at midday, roasted meat, 2 to 4 ounces (60 to 120 Gm.); fresh vegetables, cooked in water with a little salt, 1 ounce (30 Gm.); two cups of hot, weak tea without sugar; at 4 o'clock, a cup of tea; at 7 in the evening, two eggs without salt; vegetables cooked in water, and saltless bread, 1 ounce (30 Gm.); weak tea. Diuresis may be induced by  $7\frac{1}{2}$  grains (0.5 Gm.) of **theobromine** three times a day. After four or five weeks the diet may be less meager, but not more than 5 ounces (150 Gm.) of bread may be taken; butter on the vegetables and a vegetable soup at the evening meal may be allowed. In obese persons who are plethoric and have a weak heart, there is usually venous stasis, and if the labor of the heart is increased by the ingestion of considerable quantities of fluid the heart will be still further weakened. By restriction of the diet the labor of the heart is facilitated, and the organ beats more forcibly and rids itself of the fat which interferes with its functions; as the patient loses fat his hypertension lessens, and the increased cardiac power disposes of the venous stasis.

The treatment recommended by Schott combines a restricted but nutritious diet with **exercises**, **massage** to promote fat absorption, and **baths**. In the baths gradually increased concentrations of salt are employed, with the temperature gradually reduced to 76° F. (25° C.) and the duration increased to 20 minutes. The patient is enjoined not to rest after eating. The **Schott resistance exercises**, available also for other forms of cardiac disease unless the insufficiency of the organ is severe, are to be carried out slowly, at a uniform rate, with a pause after each movement, and without any feeling of exertion. The physician or other person directing the exercises always applies the resistance to the aspect of the member or body which is in advance, and avoids encircling a member. The point of application of the resistance is also adjusted, as to distance from the fulcrum, according to the relative strength of the patient and operator and the progressive increase of motor power resulting from the treatment. The following series of movements is advised by Schott: (1) Arms raised outward to the horizontal, then lowered. (2) Trunk inclined deeply to one

side, then the other. (3) One leg, then the other, abducted as far as possible, then dropped down. (4) Arms raised anteriorly to the horizontal, then lowered. (5) With hands on hips, body bent forward, then raised again. (6) One leg, then the other, raised forward with straight knee. (7) With hands on hips, body twisted to the right, then the left. (8) One leg, then the other, raised backward, with hands on a chair. (9) Arms extended outward, then inward, at level of shoulders, with the fists supinated. (10) One knee, then the other, raised to body and leg extended. (11) As 9, but with fists in pronation. (12) One leg, then the other, bent backward from knee. (13) Forearms bent and straightened from the elbows, in succession. (14) Arms raised forward and upward, then carried down and back as far as possible. (15) Arms raised to horizontal and forearms flexed, then extended. (16) Arms carried back from anterior horizontal position, then forward again.

The bowels should be made to move rather freely and easily by means of properly selected articles of food, and, these failing, mild **laxatives**.

(See also the treatment of the obesity in such cases at the end of the section on **FATTY OVERGROWTH**.)

## **FATTY OVERGROWTH.**

**DEFINITION.**—Fatty overgrowth of the heart is characterized by an abnormal accumulation of fat about the surface of the organ and the interstitial tissue. It is also termed **fatty infiltration** when the interstitial tissue is alone the seat of an abnormal deposit of fat.

**SYMPTOMS.**—A well-marked degree of fatty overgrowth may be unaccompanied by any symptoms, although the bodily vigor may be impaired. These cases are usually combined with general obesity.

Simple sign which is almost pathognomonic of fat-heart even at a period when other indications of its

presence are still wanting: Normally the heart sounds are less distinctly audible when an individual is in the recumbent or reclining than when in the erect position. The increase in loudness and sharpness of the heart sounds when standing is especially noticeable after moderate bodily exertion. When, on the other hand, fatty overgrowth of the heart is present, this increased loudness of the cardiac sounds when in the upright position (and after moderate exertion) either does not ensue at all or is only insignificant. Stern (Archives of Diag., July, 1912).

The muscle-fiber of the myocardium is weakened (not degenerated, as a rule), and as a consequence dilatation of the organ tends to supervene; this excites dyspnea upon exertion. Under these circumstances, if extra labor is suddenly thrown upon the organ, from any cause whatsoever, the clinical indications of a weak heart (urgent dyspnea, precordial discomfort, palpitation, vertigo, syncope, cyanosis) promptly appear and become pronounced, followed later on by recurrence on every provocation.

Distressing attacks of asthma may develop after a full meal, or in the absence of any apparent exciting cause. A passive form of bronchitis, probably secondary to a weak heart, attended with the customary symptoms,—cough and a slightly colored expectoration,—often arises.

Inspection shows a feeble, diffuse apex beat, though in marked obesity I have frequently found it absent. Palpation serves to confirm the existence of a feeble impulse, which may be occasionally missed; decided arrhythmia may be noted. The radial pulse is variable, though, as a rule, regular and moderately tense. Percussion yields dullness over an in-

creased area, although this is not demonstrable in excessive obesity. Auscultation renders audible the feeble heart sound in marked cases, and, with increasing dilatation, a systolic apical murmur. In moderate grades the heart sounds may be clear.

The urine of 996 obese patients examined, and sugar found present in 10 per cent. of that number. The percentage of diabetics seems to increase with the degree of obesity. Wolfner (Berliner klin. Woch., Jan. 28, 1901).

In **fatty infiltration**, which may be associated with grave forms of myocardial degeneration, the symptoms develop abruptly, after some unusual muscular exercise or after a profound systemic shock. More commonly, however, the clinical indications, which are not sharply defined as a rule, manifest themselves in a gradual manner. The principal features are urgent dyspnea (often an asthmatic form of breathing) and utter exhaustion upon muscular exercise, precordial discomfort, pain under the sternum, cardiac palpitation, arrhythmia, syncope, vertigo, cyanosis, and angina pectoris. Marked and constant disturbance of the cardiac rhythm is symptomatic of fatty infiltration. Hydrostatic bronchitis, with cough and expectoration, is commonly present. The angina pectoris may be dependent largely upon associated sclerosis of the arterial system. Emotional disturbance and mental apprehension are the chief nervous phenomena. The *physical signs* are neither constant nor characteristic; they are, in the main, those of cardiac dilatation. The *pulse* may be regular and of good tension, but after dilatation comes on it becomes irregular, frequent, and easily compressible.

Moderate hypertrophy probably exists in the majority of cases, but cannot always be demonstrated owing to the extreme subpericardial overfatness. A basic systolic murmur may be heard; it is not due to valvulitis as a rule.

#### DIFFERENTIAL DIAGNOSIS.—

The diagnosis rests upon the combined presence of marked obesity and a weak heart. Although there is little danger of confounding fatty overgrowth with other cardiac affections, the fact is to be kept in remembrance that its persistence favors the occurrence of fatty degeneration, and it is not always possible to discern the sequence, since, as will appear hereafter, fatty degeneration may exist without engendering symptoms.

Certain points of distinction will be found in the division on FATTY DEGENERATION.

**ETIOLOGY.**—The chief etiological factor is general corpulency. Among conditions *predisposing* to fat-production may be mentioned: (a) Heredity: in about 50 per cent. of the cases of obesity the tendency is inherited, and in these the abnormal accumulation of fat shows itself quite early in life. (b) Climate: corpulence occurs with relatively increased frequency among the inhabitants of hot, moist countries, and of low countries of the temperate and Arctic regions. (c) Habit and occupation: the sedentary habits of the rest-loving, phlegmatic temperament predispose to fat-increase, while all sedentary occupations act in a similar manner. (d) Race: Jews are particularly subject to obesity, and the same may be said of races inhabiting certain hot, moist climates (*vide supra*); e.g., southern Italians, South-Pacific Islanders, and certain African peoples.

(e) Age and sex: acquired obesity most frequently arises in persons of advanced middle life, between 40 and 50 years, while the congenital form is seen in infancy and childhood. The fat-heart is never found in infancy (Cutler). Corpulency is more frequent among women (particularly Jewesses) than among men, and in the former sex it often appears at puberty and between the thirtieth and fortieth years. (f) Certain diseases and conditions may predispose (anemia, paraplegia, and loss of blood and of other fluids. (g) Congenital anomalies and monstrosities (idiots, cretins, acephali).

The *exciting causes* may be tabulated as follows: 1. Inebriety; the intemperate use of alcoholic beverages, especially in the form of beer, ale, porter, and the like. 2. Ingestion of fat-making food in excess. Excessive use of fats, starches, and sugars, although the too free indulgence in proteids may also be responsible, especially with insufficient physical exercise. 3. The prolonged use of arsenic may sometimes lead to corpulence.

Fatty infiltration is often suspected during life in cardiac patients who exhibit a general tendency to obesity, but there are no definite clinical signs by which it can be recognized. Dyspnea and palpitation are symptoms of cardiac embarrassment in the obese, but they are also such in patients of slender build. Increase in the transverse diameter of the heart exists when it is subject to fatty infiltration, and it also exists when there is no evidence of fat deposit in heart tissue. Faint and muffled heart-sounds are similarly non-distinctive. S. Calvin Smith ("Heart Affections," p. 196, 1920).

**PATHOLOGY.**—The characteristic change consists in an abnormal

deposit of fat, more especially in places where this tissue-element is normally found, as the auriculoventricular grooves, near to the apex, and about the great vessels at the base. This overproduction of fat is present in every obese person, and when excessive may form an enveloping mantle, first covering the right ventricle, later the left also, attaining a diameter of an inch or more. The surface of the fat-heart generally presents a pale-yellow hue, but may be a deep-yellow color, resembling sulphur. The intermuscular fibrous tissue, as may be seen on section, is the seat also of increased accumulation of fat. In extreme cases the muscular fibers undergo atrophy, thus becoming weakened, from inordinate pressure.

Dilatation often supervenes, and it is quite probable that the symptoms, when present, are dependent upon, and date from the time of, its occurrence. Rupture of the organ is also not unlikely. A coronary artery and the aortic arch are often arteriosclerotic. In the cachexias of carcinoma and phthisis, and in the general atrophy of the aged, fatty infiltration and fatty degeneration coexist.

**PROGNOSIS.**—Cases in which fatty degeneration has not as yet been set up afford a favorable prognosis, especially if the cause be removable. On the other hand, in long-standing cases of excessive obesity, more or less fatty change of the muscle-fiber may be safely inferred to exist, and the outlook is dubious, though much will depend upon the special cause and its degree of removability, as well as the presence or absence of serious complications. Among the latter, the more important are arteriosclerosis,

albuminuria, glycosuria, anginal attacks, pulmonary congestion, edema, and the like. Permanent results are not always attainable in cases dependent upon the patients' habits, since the latter are liable to relapse into them after a variable degree of improvement.

In fatty infiltration, especially when associated with forms of myocardial degeneration, the prognosis as to cure is almost hopeless, although marked improvement may follow appropriate treatment. A fatal termination is often due to spontaneous rupture of the heart.

**TREATMENT.—Prophylaxis.**—Although such cases generally first come under observation too late to receive the benefits of prophylactic measures, there are, nevertheless, many favorable opportunities presented to the wise family physician to attend to this important matter, even in the earlier years of those showing an hereditary predisposition to obesity. The fat-forming foods, particularly the carbohydrates, must be greatly restricted in the dietary. The amount of liquid must also be diminished, as a rule.

Case of a young woman with a nervous taint whose weight fluctuated remarkably at times independently of the amount of food consumed. The difference was evidently due to retention of fluid, though there was no actual edema, and displayed unmistakable connection with emotional stress and the onset of the menses. Between morning and night the patient's waist and bust measure would sometimes increase so that she was unable to get into her clothes. Bernouilli (*Correspondenzblatt f. schweizer Aerzte*, March 10, 1910).

Fats and proteids are allowable, and their proportions must be regulated

according to the amount of muscular activity. **Systematic exercise**, in the fresh, open air, along with **cool baths**, are measures to be adopted. Persons in middle life who manifest a predisposition to corpulency should be cautioned against all imprudences in eating and drinking; they should pursue a prescribed dietary, in which not only the character, but the quantities, of the various substances allowed should be noted. If there be the slightest tendency toward anemia, an **open-air existence**, short of injurious exposure, is imperative. **Gymnastics** and **outdoor sports**, if wisely regulated, should play a part in the prophylactic management of these cases. If anemia be associated with fatty overgrowth, then greater care and caution must be exercised in recommending physical exercise, the amount of liquid may be much **diminished**, and the fat-forming dishes should be rigidly excluded. I have long been prescribing **arsenic**, **strychnine**, and **iron**, in small doses, in such cases.

**Treatment of Fatty Overgrowth.**—The system introduced by **Oertel**, as I have observed personally, promises excellent results if faithfully carried out. Among contraindications that should be heeded are marked **atheroma** and **chronic valvular disease** of the heart, particularly in cases that have passed into the stage of **broken compensation**. The method will be briefly described. It comprises three parts:—

1. The **reduction of the amount of liquid** taken with the meals and during the intervals, the total for each day being 36 ounces (1064.0). Additionally, **frequent bathing**, and in suitable cases the **Turkish bath** and

**pilocarpine**, are employed to induce free diaphoresis.

2. The **diet** is composed largely of **proteids**, as follows:—

*Morning.*—A cup of coffee or tea, with a little milk—about 6 ounces (180.0) altogether; bread, 3 ounces (93.0).

*Noon.*—Three to 4 ounces (90.0 to 120.0) of soup; 7 to 8 ounces (218.0 to 248.0) of roast beef, veal, game, or poultry, salad or a light vegetable, a little fish; 1 ounce (32.0) of bread or farinaceous pudding; 3 to 6 ounces (93.0 to 186.0) of fruit for dessert. No liquids at this meal, as a rule, but in hot weather 6 ounces (180.0) of light wine may be taken.

*Afternoon.*—Six ounces (180.0) of coffee or tea, with as much water. An ounce of bread as an indulgence.

*Evening.*—One or two soft-boiled eggs, 1 ounce (32.0) of bread, perhaps a small slice of cheese, salad, and fruit; 6 to 8 ounces (180.0 to 240.0) of wine, with 4 or 5 ounces (120.0 to 150.0) of water (Yeo).

3. **Graduated exercise** up slight elevations and inclines, the distance to be undertaken each day being carefully specified, beginning with slight efforts and frequently, though gradually, increasing them. A similar plan is to be pursued with reference to the degree of inclination, and it is to be recollected that this is the most important part of the **Oertel system**, since it directly and methodically invigorates the heart-muscles.

Case of fatty heart in a woman of 40, weighing 220 pounds, who had been asthmatic and suffered from *delirium cordis*, and from time to time anginoid attacks. Similar case in a woman of 50, who weighed 310 pounds, in whom there was, besides extreme dyspnea, cyanosis and ex-

haustion on exertion. In the latter appropriate treatment reduced the weight 125 pounds, and the patient recovered. Fatty infiltration of the pericardium probably existed in this and other cases reported in which reduction of weight caused very marked improvement. Anders (Amer. Jour. Med. Sci., April, 1901).

Antifat cures are dangerous in this class of cases, and, as a rule, thyroid gland is not well borne. Care should be taken not to produce too rapid emaciation, thus allowing the heart to gradually adjust itself to its improved condition.

The writer can recall more than one instance in which the appearance of cardiac incompetency followed very promptly an antifat cure. It is particularly true in people of middle age. In persons younger, say under 40, reduction cures are safer and yet not wholly without danger. But in persons who have passed 40 any attempt to effect weight reduction by starvation diet and by vigorous exercise is certainly injurious for the reason that in such persons the cardiac system has suffered more or less degeneration. R. H. Babcock (Boston Med. and Surg. Jour., Sept. 3, 1908).

Extreme and too rapid starvation of the heart muscle is positively dangerous to life in those with organic heart disease or those who are weak or well advanced in years. Starvation may increase the adynamia of the heart from the loss of tone of the muscular fiber. There are worse conditions than superfluous flesh. R. G. Curtin (Boston Med. and Surg. Jour., Sept. 3, 1908).

### RUPTURE OF THE HEART.

Rupture of the heart occurs rarely. The rupture may be *complete*, in which condition there is complete solution of continuity of the total diameter of the myocardium; or *partial*, the latter including laceration of

the trabeculæ ventriculi whereby the chordæ are liberated. Occasionally the papillary muscles are torn, causing valvular incompetency.

**SYMPTOMS.**—In most instances rupture of the heart results in sudden death. Sometimes, however, the patient survives the accident for several hours or even for as many days. The symptoms are those of internal bleeding, and pain that may be agonizing and is referred to the heart. The body-temperature falls, the skin surface becomes pale and cool, and it may be covered with cold perspiration, while the pulse grows small, very frequent, and finally almost vanishes. Occasionally gastrointestinal symptoms and syncope tending to convulsions appear in consequence of the irritation of the vagus centers due to cerebral anemia. The physical signs of cardiac failure rapidly develop, and, if the leak be not too large, those of pericardial effusion more gradually.

**DIAGNOSIS.**—Heart-anguish, rapidly progressive cardiac failure, the evidence of internal hemorrhage, and the speedy development of the signs of pericardial effusion should always excite suspicion of rupture, and in many cases suffice for a correct inference.

**ETIOLOGY.**—Predisposing and exciting causes may both be at work. The former are the more important and named in the order of their frequency of occurrence are,—disease of the coronary arteries (with associated anemic necrosis and abscesses), fatty degeneration, chronic myocarditis, parietal tumors, and parasites in the heart-wall.

The influence of age is notable; rupture of the heart usually occurs after

the sixtieth year has been passed. Males suffer somewhat more frequently than females. The exciting cause is, as a rule, some form of muscular exertion, though it may occur during sleep.

**PATHOLOGY.**—The most frequent seat of rupture is the anterior wall of the left ventricle, though it may also occur in the right ventricle and in the auricles. The rent runs parallel with the muscular fibers, and is to a certain extent the result of laceration, although chiefly of a separation, of the fibers. The fissural communication presents irregular edges, and at autopsy is seen to contain blood-clots; the pericardial sac is also occupied by coagula. If pericardial adhesions have previously obliterated the cavity, the escaped blood-clots may occupy the pleural cavity. Histological examination of the adjacent muscle-structure shows the characteristic changes of fatty and other forms of degeneration.

The **PROGNOSIS** is hopeless unless surgical measures can be resorted to. When immediately fatal, death is the result of heart-shock; it may result from anemia of the brain or compression of the heart by the effused blood.

**TREATMENT.**—*Prophylaxis* is of the utmost importance. The physician should give ample warning of the dangers connected with muscular strain of whatever sort. If rupture has either occurred or is suspected, the patient must be put at **complete rest in the horizontal position**. Full doses of **morphine** should be given **hypodermically**, and the **ice-bag** locally applied. **Warmth to the extremities** may be useful. The use of cardiac stimulants will be attended

with increased bleeding from the rent, but agents that relax the peripheral arterioles, such as **nitroglycerin**, may be employed with a view to diminishing the heart's labor without diminishing its power. Should the rupture be partial and the hemorrhage slight, the patient's life may be prolonged, or even saved, by keeping him at absolute rest for a long period. The patient should be afforded the chances of recovery which **surgical measures** sometimes procure, the case being treated as one of stab-wound. (See Vol. III, p. 150.)

### **BROWN ATROPHY OF THE HEART.**

This is a form of degeneration in which accumulations of yellowish-brown pigment-granules occur in the muscular fibers. The color exhibited by the heart-muscle is a reddish brown, and in pronounced cases a dark-red brown. Brown atrophy is most commonly seen in the hearts of the aged, though also quite often in cases of chronic valvular disease that have reached an advanced stage.

### **CALCAREOUS DEGENERATION OR CALCIFICATION OF THE HEART.**

Calcareous infiltration of the muscular fibers of the myocardium has been observed, though very rarely. In a recorded case by Bramwell, there were, besides calcareous degeneration of the heart, subcutaneous tumors in the axillæ, elbows, groins, natal folds, and popliteal spaces, with symptoms suggestive of Addison's disease, in a young man aged 25 affected with advanced cirrhosis of the left kidney, the right kidney having been completely destroyed fourteen years previously by a pyelonephritis. Somewhat more

common are the bony callosities that result from myocardial abscesses, in the course of circumscribed myocarditis.

### AMYLOID DEGENERATION.

This is a pathological condition rarely met with. It is limited to the blood-vessels and interstitial connective tissue; its causes are the same as those of amyloid degeneration of other viscera.

Closely allied with this condition, though occurring independently in prolonged fevers, is **hyaline degeneration**. Here the fibers are swollen, translucent, and homogeneous and their striæ almost obliterated.

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### HEART, GRAPHIC METHODS IN THE EXAMINATION OF THE.—

Graphic methods are used in medicine chiefly to record tracings of cardiovascular, respiratory, and muscular movements.

**POLYGRAPHY.**—Polygraphy is a method of recording two or more tracings simultaneously on kymographic paper actuated by a motive force, usually clockwork or electricity. The paper is attached to the surface of a metal drum, or sometimes to two drums. Of the tracings one may be made to mark the intervals of time in seconds or fractions of seconds. Kymographic paper is usually white with a smoked surface, the tracings made by the pen-arm or stylet revealing the paper and so appearing as white. This method records the precise length of a cardiac cycle, the several events being registered in waves and depressions. By this means a number of features of the circulation that were formerly

unknown to us are disclosed. The tracings are truthful records of events, subject, however, to errors produced by defective instruments, sometimes by artefacts that cannot always be avoided, and also by lack of skill on the part of the operator. So, too, where there is an unusual combination of cardiac arrhythmias, even an expert may be in doubt as to the proper interpretation of each wave, wavelet, or depression.

Despite these drawbacks, tracings are fairly comprehensible registers of the various cardiovascular activities. In fact, polygraphy can be used effectively to determine the action of drugs, food, and drink on the human organism, and also such other therapeutic agencies as baths, muscular exercises, massage, and electricity. It is also a material aid in the diagnosis of cardiac disease.

In arrhythmias it led to a new classification. Polygraphy is one of the most reliable guides we have in determining abnormal cardiac conditions. It is, therefore, a method helpful in indicating appropriate lines of treatment.

The sphygmograph alone is, however, of comparatively little value, because there has never been any close agreement among physiologists and clinicians as to all the characteristics of a normal sphygmogram, nor as to distinctive curves in the various forms of valvular disease.

Sphygmograms are lacking in accuracy because the personal equation cannot be eliminated. To secure a good tracing the exploratory button or base must be placed directly over the radial, so as to press it against the bone. This is not easy. Besides, a certain, but indeterminate degree



of pressure must be employed, and, inasmuch as it is impossible to adjust the button precisely in the same spot or to use exactly the same amount of pressure in each instance, the tracings will vary in successive tests. Indeed, there is no such thing as a standard normal sphygmogram.

Age, the degree of vitality, and sex are also some of the factors that cause variations of the sphygmogram in health.

Similarly, there can never be any fixed standard for the tracings of the various diseases of the cardiovascular system.

As each individual person differs from another in health, so, even in the same disease, and in successive examinations, there are differences which will be recorded in the sphygmogram. One has but to compare the several tracings in health and in valvular diseases given by various authors to assure himself that my statement is substantiated by their experience.

Even in a single examination, the tracings will show appreciable differences, as will be shown in Fig. 2. The same statements are applicable to the cardiogram, only the variations are even more noticeable.

Yet, the sphygmograph has its uses. In fact, we cannot well dispense with it, even though its field is comparatively narrow. It may be relied on to give the frequency of the pulse when the finger is unable to count it. It will give a rough record of some cardiac arrhythmias. It is competent, moreover, according to Lewis, to detect auricular fibrillation without any other appliance. But it will not indicate the grade and quality of arterial tension as well as the

trained finger. As a key, however, to the interpretation of the jugular pulse, its tracings are most important, and in simultaneous records of the jugular, carotid, and radial pulses and the apex beat it affords a better criterion as to time than the carotid, because it is more easily isolated from the surrounding tissues.

The venous tracings obtained with the polygraph do not altogether harmonize as to interpretation with the known course of the cardiovascular activities. The cycle consists of the auricular systole and the ventricular systole, with a scarcely perceptible interval between them. The V wave in the jugular tracing, said to arise during the ventricular systole, is due to 2 factors: (1) A rising intra-auricular and intravenous pressure due to afflux; (2) a sudden fall of the pressure upon the onset of ventricular diastole. The upstroke of the V wave should accordingly be gradual and the downstroke sudden; but in the tracing the downstroke is the counterpart of the upstroke. There is thus an evident conflict between the tracing and the process held to be responsible for it. The A wave appears to conform with the auricular systole in time, but its magnitude seems disproportionately great, in view of the small power of the auricle and the block interposed by the sphincter action at the mouths of the venæ cavæ. No hint of the auricular diastole shows on the tracing, though the ventricular diastole is credited with causing so marked a feature in the phlebogram. Harrington Sainsbury (*Brit. Med. Jour.*, Apr. 14, 1923).

In the field of polygraphy, we must, for the present at least, be satisfied if its records give us practical assistance, even if they differ. Their accuracy is comparative. The case is much the same as that of the sextant which the captain of a ship uses to find his position when out of

sight of land. He cannot, except by the merest chance, determine the precise position of his ship, because he has no stationary mark to assist him, but he nevertheless usually locates his position on the chart with a sufficient degree of accuracy for practical purposes. The analogy holds good with many of the instruments in use in medical practice. They assist us materially in framing our diagnoses. Of all the graphic instruments the electrocardiograph is the most accurate, and yet the character of its curves varies according to the

and letters used in these illustrations will be those of the English system, as used by Lewis. Unfortunately, there has been hitherto no uniform system of notation, and much confusion has resulted. The accepted intervals of time in Figs. 1 and 2 are those of Mackenzie, who makes the cycle occupy  $\frac{1200}{1000}$  seconds, while Michael Foster puts it at  $\frac{1130}{1000}$  seconds. The latter observer puts the duration of ventricular systole at  $\frac{451}{1000}$  and the duration of ventricular diastole at  $\frac{679}{1000}$  second. Lewis puts the length of the cycle at  $\frac{1010}{1000}$  seconds, the ventricular systole at  $\frac{350}{1000}$  second, and the ventricular diastole at  $\frac{470}{1000}$  second. Of course, the length of the cycle varies with the frequency of the pulse. If a pulse of 72 has

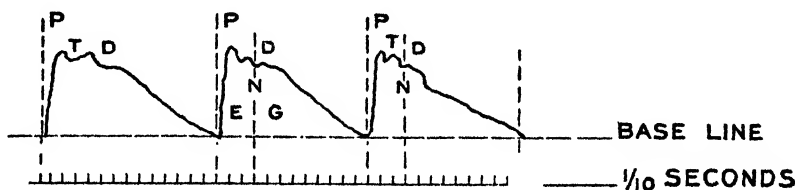


Fig. 1.—Schematic plan of a normal sphygmogram.

so-called "leads" that are used,—a point that is now generally recognized.

In Fig. 1 is shown the scheme of a normal sphygmogram in a healthy man with a pulse of 72. The space *E* marks the period of ventricular systole, which in this instance occupies about  $\frac{3}{10}$  second. This is the sphygmic, or pulse, period. The space *G* marks the ventricular diastole, and occupies about  $\frac{4}{10}$  second. The nearly vertical upstrokes *PP* are known as the percussion waves; the tidal waves *TT* follow. At *DD* are seen the diastolic waves, while *NN* represent the diastolic notches. An imaginary line runs horizontally through the lowest points of the upstrokes, and is known as the base line, while under it the intervals of time are marked by the chronograph in seconds and fractions of a second. The waves, wavelets, and notches and their time relations to one another are of great importance in deciphering the significance of a jugular tracing such as is seen in Fig. 2.

As far as possible, both the numbers

a cyclic length of  $\frac{12}{10}$  seconds, a pulse of 60 will have a cyclic length of  $\frac{10}{10}$ , or 1, second. More than this, and as a corollary to what has already been said, there is no absolutely fixed relation in time between the periods of ventricular systole and diastole of either ventricle, carotid, or radial, as may be seen by measuring these intervals in Fig. 2 with a pair of dividers.

In Fig. 2 the carotid wave shows a nearly vertical upstroke, due to the sudden rise of blood-pressure caused by ventricular systole. It is followed by a long and irregular downstroke, due to the gradual fall of blood-pressure. The first or tidal wave is due to secondary contraction and expansion of the artery immediately after its primary systolic contraction. The second wave, called the recoil or diastolic wave, is caused by the recoil of the blood column due to the closure of the aortic valves. The carotid upstroke precedes the radial upstroke from  $\frac{1}{10}$  to  $\frac{2}{10}$  second.

In the jugular pulse, *A* is the auricular wave, *C* the carotid wave, and *V* the ventricular wave; *X* is the carotid depression

and  $X'$  the auricular depression, while  $Y$  is the ventricular depression.

The numerals 1 to 6 refer to contemporaneous events in the four tracings, so that their effects can be plainly observed in each case. At 1, auricular systole is seen in the jugular. At 2, ventricular systole begins in the ventricles. At 3, the aortic and pulmonary valves open. At 4, the radial is seen to be contracting about  $\frac{1}{40}$  to  $\frac{1}{20}$  second after the carotid. At 5, the aortic and pulmonary valves are closing. Between 1 and 3 is the interval between the beginning of the auricular systole and the opening of the aortic valves. It is known as the  $A$ - $C$  interval.

stroke (5-6). The upstroke marks the beginning of ventricular systole, and may be preceded by a minor wave ( $A$ ) due to systole of the left auricle. Ordinarily the cardiogram fails to show this auricular undulation, but faint indications of it may be seen in the radial tracing of this polygram. It is usually well shown in the electrocardiogram. The sloping line of the apex tracing (5-6) is often rippled by other subsidiary waves. Chronologically, the systolic plateau corresponds to the impact of the heart against the parietes during ventricular systole, and from this summit the downstroke falls with moderate obliquity to the base line. The wave

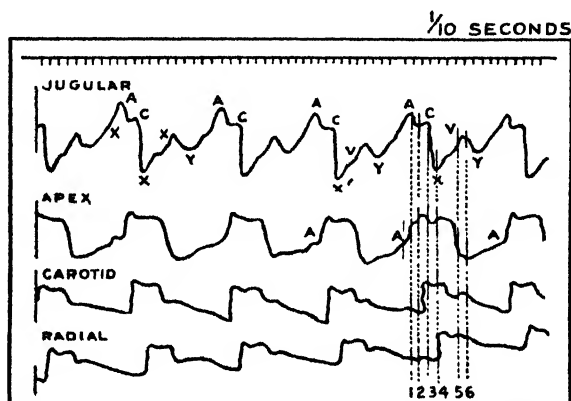


Fig. 2.—Simultaneous tracings of jugular, radial, and carotid pulses and apex beat. An adaptation of a Mackenzie polygram in a healthy man with a pulse of 72, where the length of the cardiac cycle is  $\frac{12}{10}$  second.

Apart from the two normal oscillations of the downstroke, as seen in the radial and carotid, there are other miniature waves, some of which are referable to the inherent elasticity of the arterial walls, and some to instrumental or other causes, such as auricular or ventricular fibrillation. It will be seen that the apex of the normal arterial tracing (Fig. 1), or the angle between the upstroke and downstroke, is nearly that of a right angle, while of the two minor downstroke waves the recoil is more conspicuous than the tidal. This angle in many cases is quite acute, as may be seen in this illustration.

The cardiogram, shown by the tracing of the apex of the ventricle in Fig. 2, consists of a nearly perpendicular upstroke, a nearly horizontal line, the systolic plateau (3-5), and an oblique down-

following immediately after the downstroke (5) coincides with ventricular diastole.

The phlebogram, as illustrated by the jugular tracing in Fig. 2, is composed of three distinct waves. The first of these, the auricular, or  $A$ , wave, anticipates ventricular systole, being coincidental with the contraction of the auricles. The second wave ( $C$ ), commonly called the carotid, is to be attributed to the communicated impact of the carotid artery. The third wave ( $V$ ) is known as the ventricular; it corresponds in time with the diastolic wave in the radial. The notch after the  $A$  wave marks relaxation of the auricle; that after the  $C$  wave denotes auricular diastole; that succeeding the  $V$  wave indicates ventricular diastole and the passive period of the cardiac cycle. The  $A$ - $C$  interval is the in-

terval between the beginning of the auricular systole and the opening of the aortic valves, typified by the carotid waves in the tracings of the jugular pulse. (Figs. 2, 5, and 8.) This *A-C* interval is usually about  $\frac{1}{6}$  second.

When there is the ventricular type of jugular pulse, the jugular pulse corresponds in time to the systole of the ventricles, *i.e.*, venous systole and venous diastole are contemporaneous with ventricular systole and diastole. Contrary to opinions that have heretofore been expressed, the venous pulse can usually be found and registered, though the method is not always easy (Barringer). Anything that produces increased venous pressure, such as intrathoracic tumors or abdominal pressure, or lying down is likely to cause prominence of veins such as the jugular.

Fig. 3, adapted from Lewis, gives a schematic representation of the waves and depressions of the carotid, aortic, ventricular, auricular, and jugular beats, as compared with the electrographic tracing. The several curves are a compound made up of many tracings in individuals whose pulse is set at 60. The length of the cycle is therefore 1 second. It will be noted that in the auricular and jugular tracings there is much variation as to the nature of the waves; also that in the electrocardiogram both the waves *R* and *T* anticipate in time the auricular and final ventricular waves as seen in the ventricular tracing. The *P*, *R*, and *T* of this electrocardiogram correspond to the *A*, *J*, and *F* of the Einthoven electrocardiogram. It is supposed that the electrogram registers the contractions of the papillary muscles, which precede those of the main part of the heart wall.

Fig. 3 gives a fairly correct view of the contemporaneous happenings in the different cycles, though, as has already been said, there is such a variation in any individual in the length of the cycle and in the prominence and position of the waves and depressions that no one of the tracings can be considered as more than approximately correct.

Now, the cardiogram, which is the record of the apex beat, taken either

immediately over the seat of the visible impulse, in the fifth interspace or in its vicinity, in the second, third, or fourth space, or in the epigastrium, helps us also to interpret the venous pulse tracing. The cardiogram can, besides, indicate whether the left or the right ventricle makes the impact,

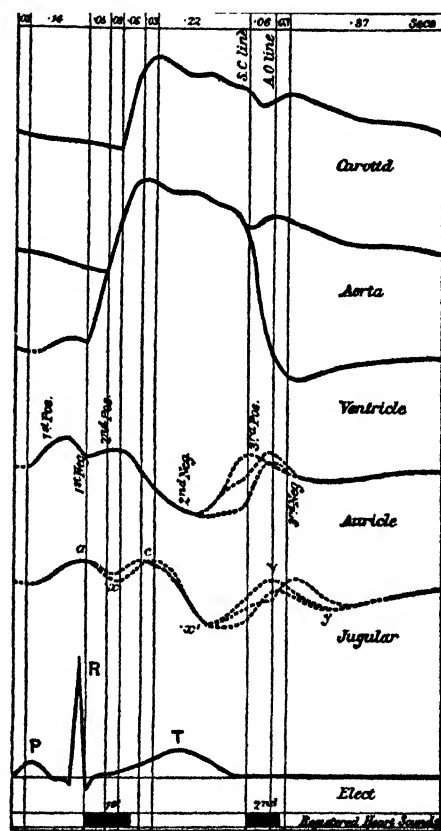


Fig. 3.—Diagrammatic representation of tracings taken simultaneously. (After Lewis.)

for when the right apex makes the impact the tracing is inverted. (See Fig. 9.) When the apex beat is not clearly felt, a tracing of it may sometimes be obtained in the epigastrium, but it may be necessary to put the patient in the sitting position.

The phlebogram gives the record of only the right ventricle and right auricle, while the sphygmogram gives

the record of both the left ventricle and left auricle. Polygraphic methods thus give a record of events in the four chambers of the heart.

as in Fig. 5, where the auricular impulse is shown at *a* and the carotid at *c*.

It is necessary to be particular and not place the receiver over the carotid. If there is a vessel in the neck that is promi-

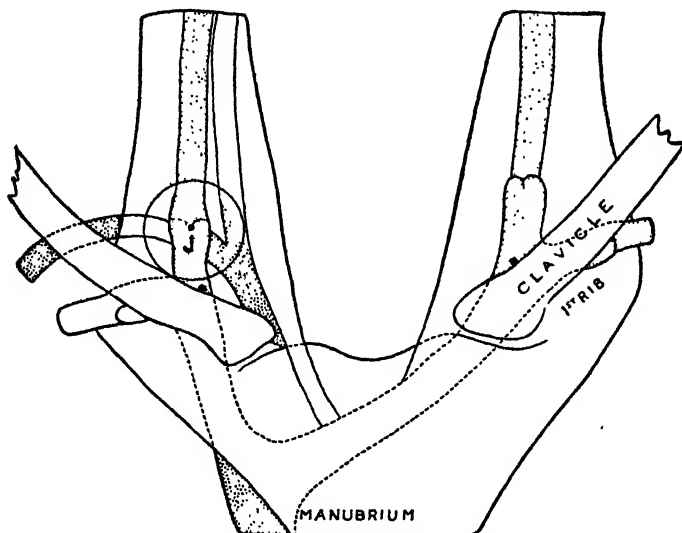


Fig. 4.—J, site of the jugular bulb. (After Mackenzie.)

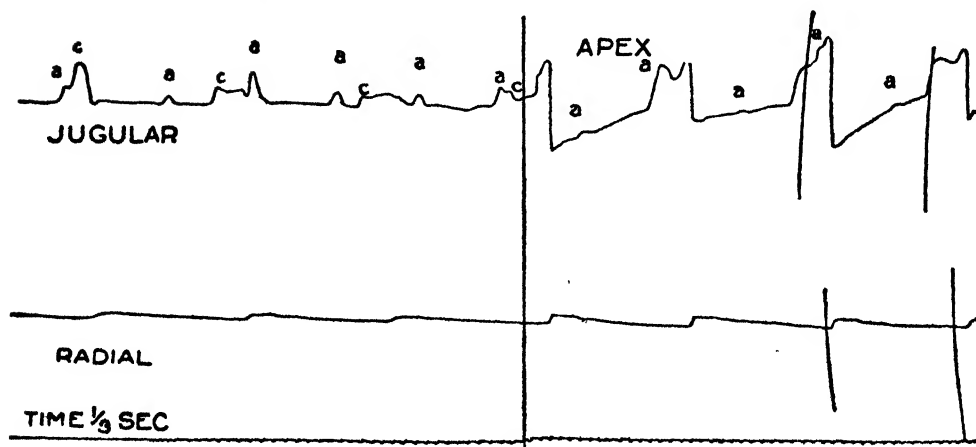


Fig. 5.—In this illustration is seen on the right the tracing of the apex (left ventricle). The waves at *c* denote the impression recorded on the jugular tracing by the action of the carotid. The case is one of complete heart block, the ventricles and auricles operating quite independently of each other, as seen by the total lack of uniformity in the *a-c* intervals. This tracing was taken immediately over the point of cardiac impact by T. B. Barringer, Jr.

Fig. 5 shows a combined jugular and carotid tracing, for if the receiver is placed over the jugular bulb, on the right side (Fig. 4), it is practically impossible to eliminate the pulsation of the carotid, which thus appears in the jugular tracing,

and pulsating it is the jugular, though as a rule it is not visible, being covered by skin, more or less fat tissue, and the sternomastoid. Examination is best made with the patient lying on the back with the head turned to the left.

The method of analyzing the jugular tracing in a normal radial pulse of 72 is as follows (Fig. 6): Make a downstroke at right angles to the time-marking line, at the beginning of the radial upstroke

responds to the middle wave; in fact, it makes this wave. It is, accordingly, to be marked C. Now measure the distance from the beginning of the tracing to 3. Measure a like distance off in the jugular,

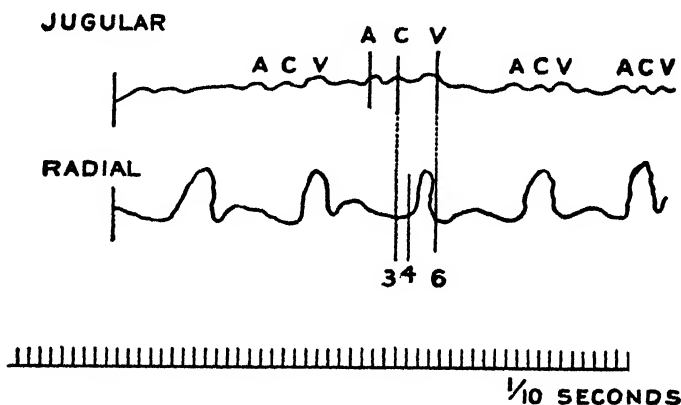


Fig. 6.—Method of deciphering the jugular pulse.

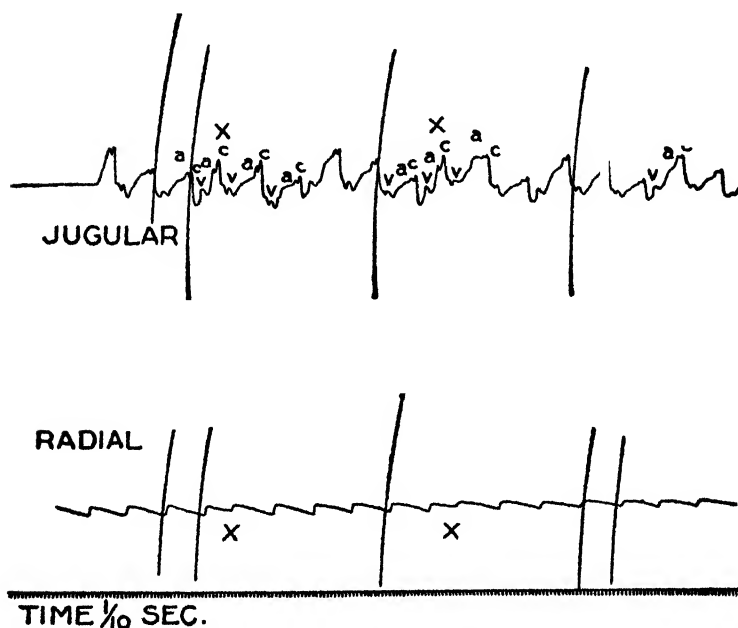


Fig. 7.—Extrasystolic arrhythmia of the auricular type. The letter *a* indicates auricular contraction of the right auricle; *c* the carotid wave, and *v* the ventricular wave. At *X* are extrasystoles of the auricular type. Tracings taken by T. B. Barringer, Jr.

marked 4. Then draw another vertical line  $\frac{1}{10}$  second or so in advance of it, so as to pass through the top of the middle jugular wave of the three in series. The carotid wave, as we have seen, anticipates the radial by  $\frac{1}{10}$  to  $\frac{2}{10}$  second, and cor-

and it should strike the top of the middle wave. This is a corroborative indication that the letter *C* is correctly placed. But the auricular systole occurs about  $\frac{2}{10}$  second earlier. Draw a vertical line about  $\frac{2}{10}$  second further in advance; let the line

pass through the crest of the wave, and the wave of auricular systole is thereby located. Mark it *A*.

The dicrotic notch, which corresponds approximately to the top of the third jugular wave, marks the closure of the tricuspid and mitral valves. Mark this point with the letter *V*.

be noted that in 12 seconds only about one-half the beats have any considerable degree of force. In the jugular tracing, which is not shown, auricular systole was contemporaneous with the apex beat, showing the ventricular type of auricular systole.

It was thought until recently that the

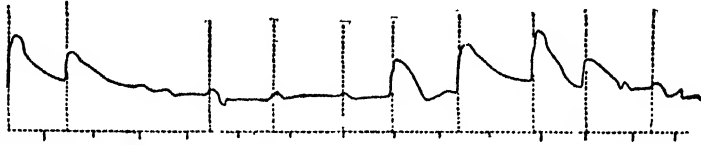


Fig. 8.—Auricular fibrillation with partial heart block in a male with Adams-Stokes disease. Pulse 30. Time markings in seconds and tenths of seconds.

These three letters are the keys to the interpretation of the jugular pulse; the letters indicating the depressions, as shown in Fig. 2, can be added if need be.

In Fig. 7 the signs  $\times \times$  denote extrasystoles. As already shown, the record

venous pulse could not invariably be traced, but Dr. Barringer has taken it in 25 successive young persons with normal hearts. Dr. Barringer made them run up three flights of stairs, and then used a rather shallow receiver of a special type.

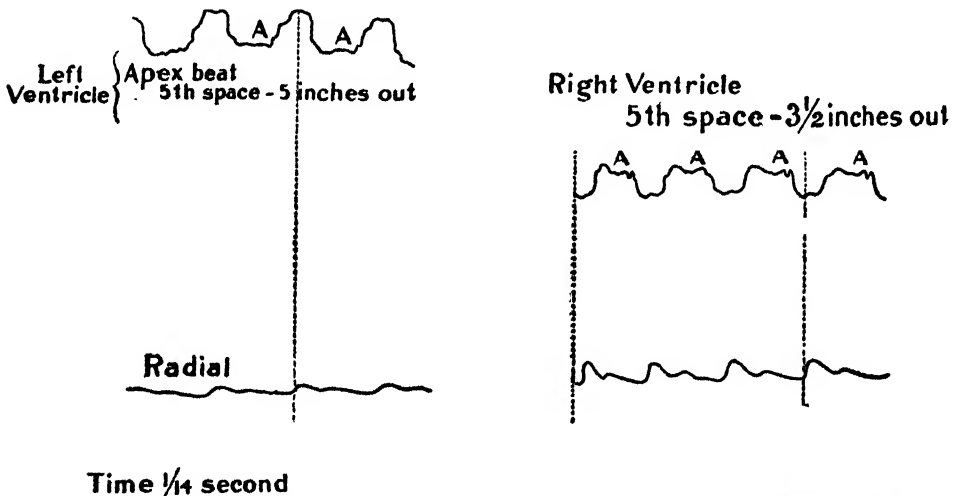


Fig. 9.—Cardiogram of a normal heart, showing on the left a tracing of the left ventricle, while on the right there is a tracing of the right ventricle, which in such cases is always inverted. Taken by T. B. Barringer, Jr.

of the venous pulse discloses more features than a record of the arterial pulse.

In Fig. 8, a tracing taken by the author, it will be seen that no two of the successive apex beats have the same length. This is, therefore, an example of auricular fibrillation. It generally occurs with the frequent pulse, when, in my experience, the prognosis is more grave. It will also

But he emphasizes the fact that the right sternomastoid must be in a state of complete relaxation, which is produced by a proper position of the head.

It may be necessary to temporarily suspend the respiration, if the respiratory curve becomes too prominent in the tracing, or it may even be necessary to take the jugular pulse on the left side.

The ordinary polygraphic machine is fitted with one or more delicate levers, each tipped with a stylet, and attached to a tambour with rubber membrane connected by a rubber tube with a receiver, which, when placed over the pulsating area, transmits the undulations to its stylet. The lever, with or without the tip or stylet, forms the so-called pen-arm, and is made to rest lightly on the surface of the kymographic paper, which is usu-

drums, and immersed in a solution either of shellac and alcohol or of benzoinum and alcohol (1 oz. in 10 oz.), after which it is hung up to dry, and then laid on a flat surface, protected from the dust. This is the best method to follow, as unless it is spread out flat before becoming fully dry the paper is apt to curl up in drying.

Mackenzie recommended two instruments for clinical work: the clinical polygraph and the ink-writing polygraph.

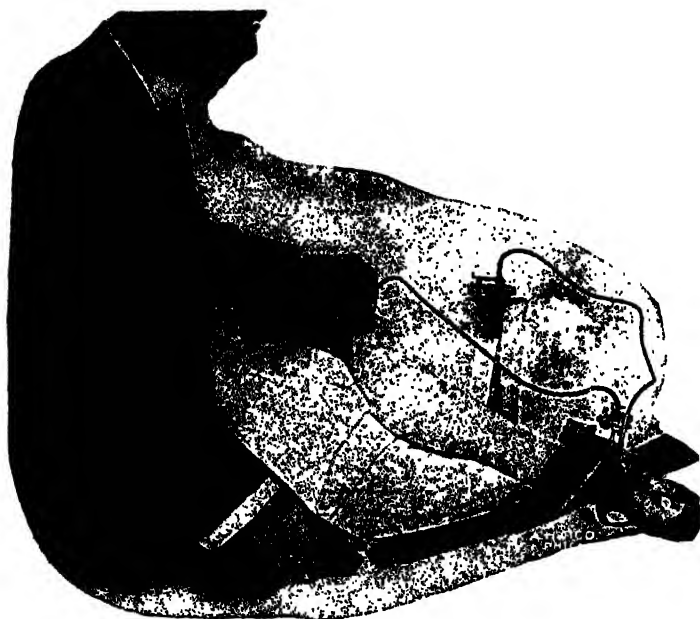


Fig. 10.—Taking a phlebogram, sphygmogram, and cardiogram simultaneously by the instrument.

ally smoked. As the paper is actuated by clockwork, or in the laboratory by an electric motor, it moves at uniform speed, while the oscillations of the pen-arm on the carbonized film make the graphic tracing.

In order to interpret the several tracings of the polygram, a chronograph, or time-marker, is necessary. This also is actuated by clockwork or electricity. After the polygram has been made, it is to be suitably labeled with the name of the patient, the date, and the locality. Afterward, the numerals and letters required for purposes of interpretation are inserted in their appropriate places. Next, the paper is carefully removed from the drum or

Both are portable. In hospital and laboratory work, larger and more complete instruments are necessary; these are, of course, more accurate, but their size and weight make them too bulky for ordinary clinical work.

When the tracing is about to be made, the patient should, as a rule, be placed in a comfortable reclining or horizontal position, with the head bent slightly on the chest. Then the operator marks with a dermatographic pencil the site of the right radial artery, just above the styloid process of the radius. The mark should be placed where the vessel is most prominent. The wrist is put at rest in an easy position, and the pad of the machine ap-



plied to the spot marked. The rubber tube is then attached to the lever, the tip of the pen-arm is approximated to the surface of the smoked paper, and the spring connected with the lever is so regulated as to get the required amplitude for the excursions of the pen-arm.

To get the jugular pulse, apply the receiver—which is a brass cup, perforated with a minute hole to allow the escape of air when applied—over the jugular bulb on the right side, at the spot (*J*) indicated in Fig. 4.

Occasionally, as I have said, it may be better to apply the receiver on the left side or higher up. The other end of the tube should be attached to the pen-arm and approximated to the kymographic paper.

In the obese, and in women with pendulous breasts, there may be no visible apex beat. In pronounced myocardial diseases it is apt to be absent. Whenever the cup or receiver is used, the finger must cover the minute air hole while the tracing is being made, so that the full force of the column of air will be transmitted to the tambour.

In taking respiratory movements such as are seen in Fig. 11, bind an ordinary rubber bag to the chest, attaching to it a tube and tambour; the respiratory movements will be traced on the moving smoked paper.

The Jaquet polygraphic machine, known as the sphygmocardiograph, is excellent for clinical work. It may be purchased of the Arthur H. Thomas Company, of Phila-

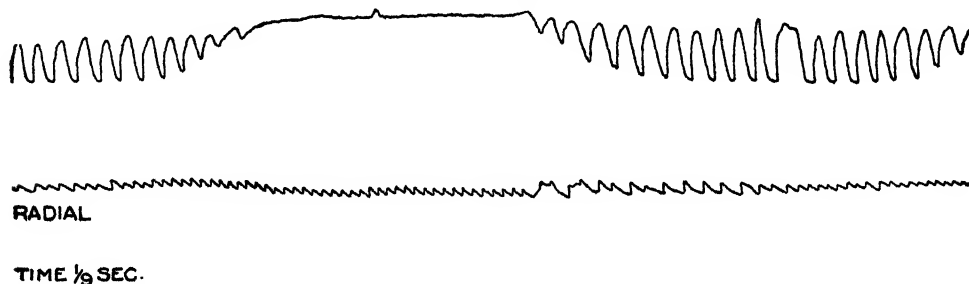


Fig. 11.—Cheyne-Stokes respiration. Taken by T. B. Barringer, Jr.

In getting the liver pulse, a special receiver is required. It should be large and oblong. After the knees of the patient have been drawn up, it is applied to the surface of the liver, being pushed up under the free border of the ribs. To this receiver one end of the rubber tube is attached and the other to the pen-arm and tambour.

A somewhat similar receiver is placed over the apex of the heart, where it is bound down by a circular band (Fig. 10). All of the pen-arms are firmly attached to a vertical metal support, which is firmly clamped to a table, bracket, or some other object that is immovable.

To record the carotid pulse, the receiver is placed at about the level of the thyroid cartilage, or at the level of the hyoid bone, on the right side. The chin should be elevated and the head turned to the left, in order that the carotid may be easily reached by the receiver.

delphia. This instrument is compact, comparatively easy to operate, and capable of registering three tracings. Though these are miniatures of the tracings made by large laboratory kymographs, they give the prominent details.

Jaquet's sphygmocardiograph (Fig. 12) is provided with a small metal plate which rests on the subject's radial artery, and is attached to a lever system carrying at its free end a delicate stylet for registering the movements of the radial pulse. A second stylet and lever system plays upon a tambour, and leads by a rubber tube to a special receiver designed for the cardiac apex or other thoracic pulsations, which is held in place by a chest strap. A third registering mechanism of similar construction communicates with a cup-shaped receiver used for transmitting the jugular impulse; a fourth, actuated by separate clockwork, marks the time. When, after adjustment, the three stylets

rise and fall with proper amplitude, indicating that the different undulations will be satisfactorily registered, the operator starts the chronograph and sets the strip in motion, adjusting it to run its whole length, while an assistant catches the paper as it passes from the rolls and guide wheels, so that it emerges without hitch from the instrument.

Marey's polygraph is bulky, but accurate.

Gibson's polygraph takes four simul-

seconds and at *c* for fifths of seconds, after which the lever is released, and the pen-arm writes the time divisions on the paper.

Probably the best polygraphic machine for research work is that of Dr. T. B. Barringer, of New York.

The Dressler-Beard Manufacturing Company, of New York, is now making an improved Mackenzie ink polygraph.

This instrument consists of a body, which comprises the apparatus for keeping the

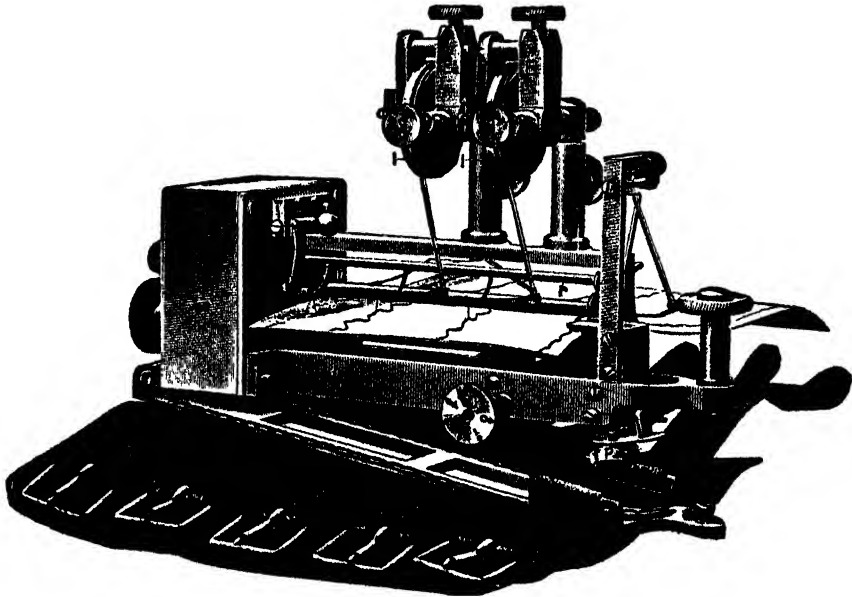


Fig. 12.—Jaquet's sphygmocardiograph.

taneous ink tracings on glazed paper, but is more expensive than either of the two already mentioned. There are many other instruments, such as those of Dudgeon, Frey, Richardson, Zimmermann, Sanborn, Mackenzie and Lutembacher.

One of the best time-markers is the Jaquet, shown in Fig. 13. It can be used in connection with any polygraphic machine. When the pen-arm (*d*) is applied to the surface of the kymographic paper, it will record time tracings with intervals of seconds and fifths of seconds. It is operated by clockwork, the dials of which are shown in the cut. When the instrument has been attached to the vertical rod at *A* and clamped in position by the screw, pressure is made on the button *b* for

paper in motion at a uniform speed, with guards or discs to keep the course of the paper straight; a time marker recording in fifths of seconds, and a speed regulator. Attached to the body by a bracket are three tambours for receiving arterial or venous pulsations or the cardiac impulse. Each tambour is fitted with a pen-arm, and the latter with split pens, each having at its extremity a small inkwell. The receivers for the venous pulse or heart beat are shallow metal cups of the Mackenzie type, each fitted in its roof with a nipple, to which is attached the rubber tubing that connects it with a tambour and writing lever or pen-arm. To secure the radial tracing a sphygmograph is used. It consists of a tambour attached to a splint, which is

strapped to the wrist and fitted with a tongue and button, by which the radial pulse is transmitted to the tambour of the body and so to the writing lever and pen. This instrument is well suited for clinical work, easily portable, and inexpensive.

able to record the cardiovascular waves automatically on the smoked paper of a revolving drum (*B*). The name cardiovascular is given to these tracings because they represent the action of heart and vessels conjointly. The pen-arm, made

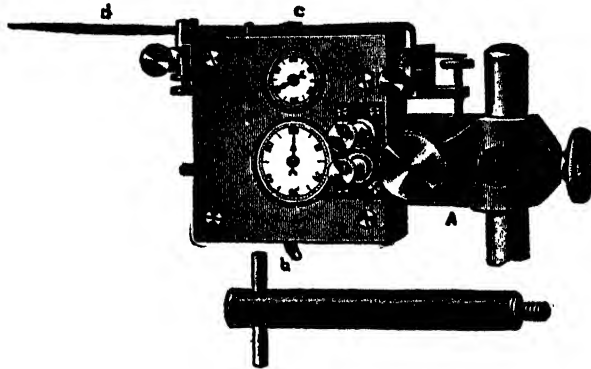


Fig. 13.—Jaquet chronograph.

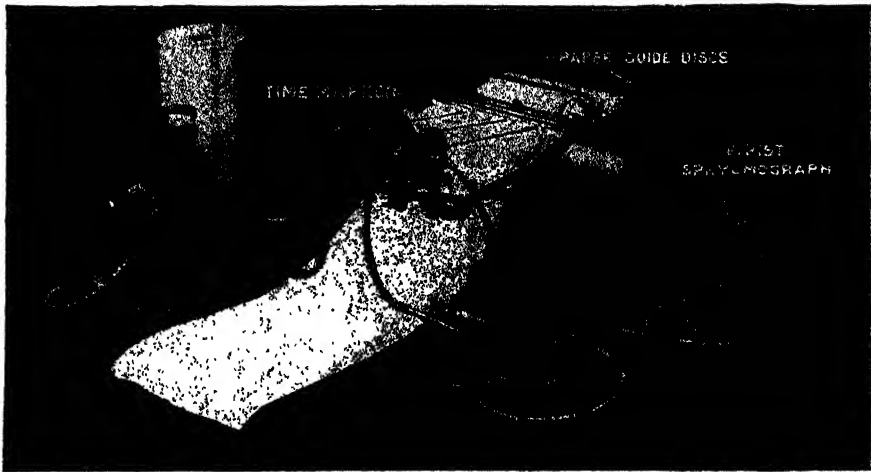


Fig. 14.—Modified Mackenzie ink polygraph.

Some of the more recent instruments are provided with a cuff to be fastened about the arm or wrist.

In my office I have been using an *automatic lever and spring recording polygraph*.

The pen-arm of the machine is actuated automatically by the levers and spring of the ordinary bathroom or office scales, on the platform of which the patient stands. The action of the heart and blood-vessels is communicated to the special pen-arm on the dial (Fig. 15, *A*), which is then

of aluminum, is heavily shaded in the diagram. Below it, another pen-arm, made of rye straw and tipped with platinum, celluloid, or tin foil, receives the impulse of the carotid or jugular, or liver pulse, or of the apex beat, as may be desired, through a brass receiver (*D*), and writes the curve on the same paper. Still below this, the metal pen-arm of a Jaquet chronograph (*C*) or an electric time marker may register the time simultaneously on the drum in seconds or fractions of seconds.

If we accept Einthoven's explanation of the significance of the waves of the electrocardiogram, as given below (see Fig. 23), the interpretation of these tracings is as follows: The tall or vertical stroke indicates the ventricular systole; the second represents ventricular contraction, or the tidal wave; the third wave, the end of ventricular contraction, or the dicrotic wave. The fourth and fifth waves represent auricular contraction. The sixth wave, if it exists, indicates the activity of His's muscle bundle.

It will be noted that there is a fair degree of coincidence between the general characteristics of the tracings made by the two machines.

While the automatic lever and spring instrument is capable of doing the work of an ordinary polygraphic machine, aided by the usual receivers, tubes, tambours, and pen-arms of polygraphic machines, I have used it more especially in studying the effects of nicotine, spirit of nitroglycerin, and caffeine on the human subject, in respect to the rapidity, duration, and force of their action on the circulatory system. In these experiments polygrams are able to furnish with reasonable accuracy a graphic record of the rate and rhythm of pulse and respiration, and of their comparative force, before, during, and after the several experiments. The requisite measurements for the determination of these several items are taken with calipers and a millimeter rule.

It will be noticed in Fig. 16 that in two instances (at ++ ) all the waves of the Einthoven tracing are shown, including the sixth or His wave, supposed to be due to the contraction of the His bundle, or Gaskell's bridge. In the middle tracing the time abscissæ are recorded in quarters of seconds by the electric time marker. In the lower tracing the time abscissæ are in fifths of seconds by the Jaquet time marker.

In Fig. 17 the upper tracing by the automatic recorder is the cardiovascular. The lower tracing, by the electric time marker, records time in  $\frac{1}{4}$  and  $\frac{1}{20}$  seconds.

In this way also a comparison can be instituted between control experiments and the direct ones. The recorder represents a kind of instrument which is

particularly applicable to the study of pharmacodynamics.

This instrument and the electrocardiographic machines have in common the advantage of registering automatically the successive events in

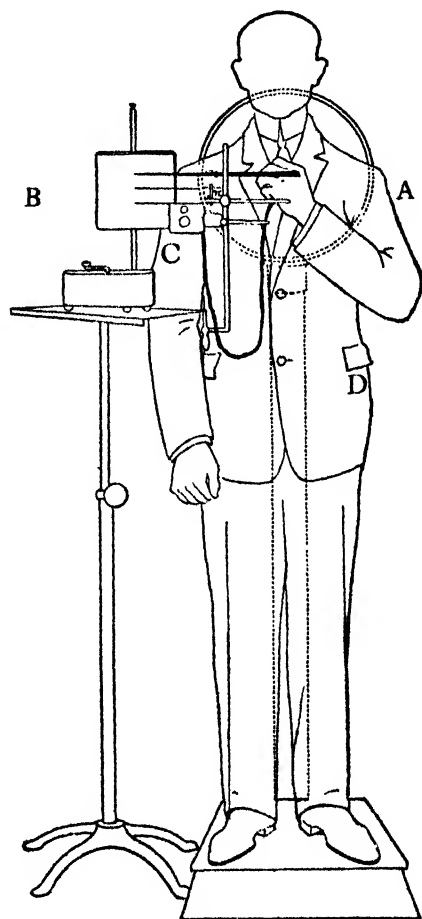


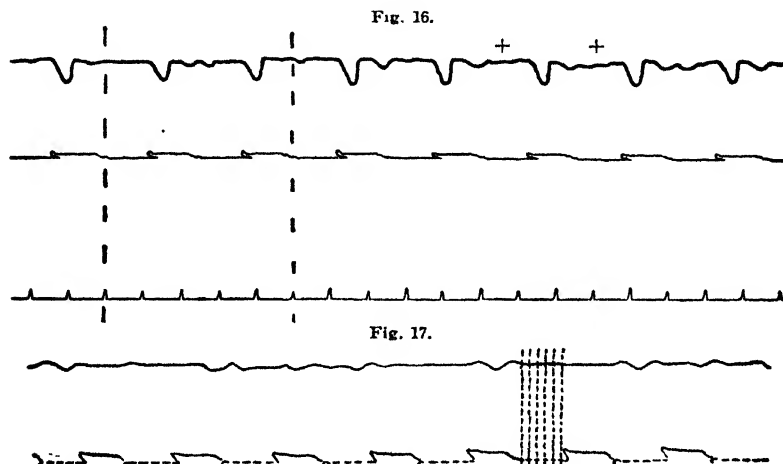
Fig. 15.—Automatic lever and spring polygraphic machine or recorder.

a cardiac cycle. All instruments that use the sphygmogram introduce a personal equation that makes their tracings of doubtful accuracy. The distinctness of the respiratory curve, as seen in Fig. 18, is also a noteworthy feature of this automatic recorder.

**ELECTROGRAPHY AND ELECTROCARDIOGRAMS.**—Muscle tissue, in the performance of its functions, evokes three things: (1) animal action or motion; (2) animal warmth; (3) animal electricity. The first of these is, of course, the most important to the economy. As com-

and Remak, working independently, in 1850.

During the last few decades, however, electrocardiography has been utilized both in medical and commercial circles. In fact, it was Ader's registration machine, as applied to submarine cable work, brought into



Figs. 16 and 17.—Cardiovascular waves as taken by the automatic recorder.



Fig. 18.—Cardiovascular tracing, showing an irregular respiratory curve, in a pulse irregular as to force and rhythm.

pared with it, the production of animal warmth and electricity are insignificant.

That electrical currents emanate from contracting muscular tissue was foreshadowed by Harvey when he published his "*Exercitatio Anatomica de Motu Cordis*," etc., in 1628. But Matteucci, in 1843, was apparently the first who actually demonstrated it, confirmation coming from Köl liker

notice in 1897, that led to the construction of the string galvanometer which is an essential element in the electrographic machine.

The instruments most in favor make use of the Einthoven or string galvanometer, or of a modified form of it. It should be stated parenthetically, however, that Lippmann, in 1873, by his invention of the capillary electrometer, had already furnished the idea of a hypersensitive capillary electric apparatus.

The idea of registering the action of heart muscle depends upon the fact that there is a ratio between the contracting force of certain heart muscles and the current that emanates from them. This fact was discovered by H. Waller, of England, as early as 1887. Putting it in another way, electrical currents are to some extent measures of the muscular action of the heart's chambers.

Now, as already said, Matteucci discovered, in 1843, that electromotive force

cillations of the column. But Marey's work was overlooked. Between 1887 and 1889 Waller was developing his capillary electrometer that registered the heart's action. Altogether it has taken over two-thirds of a century to complete the electrocardiographic machine of the present day.

For the string galvanometer, as originally conceived by Einthoven, is now the form of instrument used.

Ader employed at first a capillary galvanometer made of fine copper or alumi-

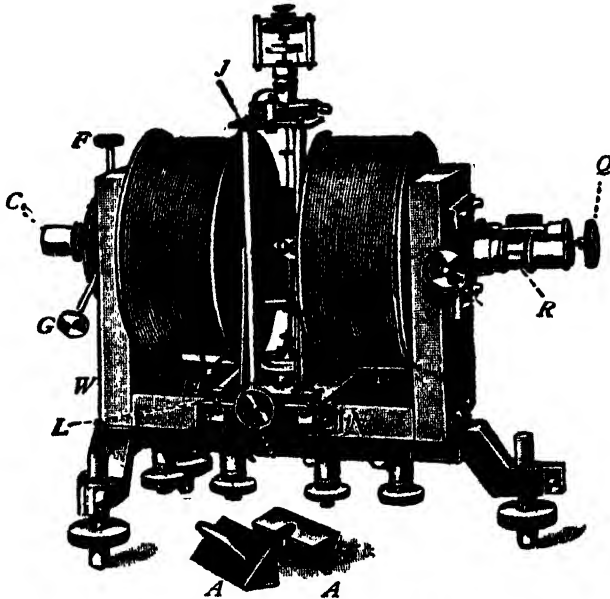


Fig. 19.—The Einthoven galvanometer, electromagnets, and microscope.

emanated autochthonously from the heart. DuBois Reymond confirmed this discovery, in 1849, by the use of a very delicate galvanometer, Remak and Kölliker following, as already stated, in 1850. Müller and Kölliker showed later (1850-1856) that there was a special current developed in the auricles during their contraction.

Lippmann, however, in 1873, appears, in addition to his invention of the capillary electrometer, to have been the first to devise a registering apparatus, though Marey, of Paris, subsequently made a very good recording instrument. The latter was able to throw the shadow of a moving column of mercury on an open space behind which was a moving sensitive plate upon which were photographed the os-

num wire which was suspended at right angles to the poles of a permanent magnet. He used a wire as much as 100 cm. long, in order to have large excursions. The diameter of the wire was about  $\frac{1}{100}$  mm.

Ader, in 1897 (*Comptes-rendus de l'Acad. des Sci.*, vol. cxxiv, p. 1440, 1897), devised his instrument, known as Ader's receptor, to supersede those of Thomson (Lord Kelvin), known respectively as the mirror receiver and the siphon recorder. By the mirror method the electric current passed through a large coil within which was a copper tube containing a magnetized needle hung by a short thread before a mirror. The needle oscillated under the action of the currents, and the

operator sitting before the mirror read the dispatch as he would read the Morse alphabet. This instrument has, however, been superseded by the siphon recorder, used very largely at the present time by the transatlantic Commercial Cable Company, of New York. It was invented by Thomson, in 1867 (Bright's Submarine Recorder, p. 630).

The siphon recorder apparatus consists of a very light coil of wire suspended between the two poles of an electromagnet, and capable of turning on its vertical axis. According to the direction of the current, the coil turns one way or the other. The

code, while another operator sitting opposite reads the Morse message and simultaneously typewrites it into the ordinary message.

Now, in the Ader recorder a long vertical wire, through which the current passes, is stretched in a magnetic field, and is drawn from side to side by the poles of the magnet, while a ray of light from a lamp throws the shadow of a minute portion of the moving wire on a moving strip of photographic paper in the form of an undulatory dotted line. This method has been used extensively by some of the French submarine cable companies,

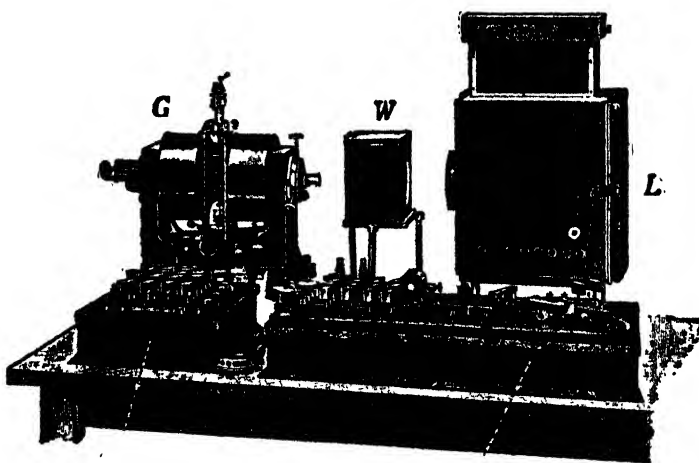


Fig. 20.—The Einthoven electrocardiographic machine fitted to a table.

motion of this coil is transferred to a capillary glass siphon, one end of which is bathed in ink while the other is approximated to a slip of paper moved by clockwork. The ink being connected with a small electrostatic machine and the paper with the earth, the ink is attracted to the paper and issues from the capillary tube with a rapid succession of spurts. When the siphon is at rest it writes a straight line on the moving paper,—in this instance a tape,—but when actuated by positive and negative currents it oscillates from one side to the other, and the deviations above and below an imaginary line correspond to the dots and dashes of the Morse code. An operator reading the marks on the paper, as they pass by clockwork before him, converts them at once, on the same paper, into the Morse

while the Einthoven machine is an adaptation of it for electrographic work in heart disease.

But Einthoven, the inventor, and Edelmann, the manufacturer, improved on the Ader galvanometer.

The galvanometer strings are now usually made of silvered quartz.

Instruments other than the Einthoven are the Hindle electrocardiograph, made in Ossining, N. Y., and the Cambridge, constructed by the Cambridge and Paul Instrument Co., Ltd., London, Eng.

In the Einthoven electrocardiograph, the poles of the magnet are perforated and illuminated, and the galvanometer, suspended at right angles to the perforations, is charged by the current of the magnetic field, while a portion of the shadow of the vibrating wire, magnified by a microscopic

lens, is thrown on the moving sensitive plate and photographed.

As the open space is a very narrow slit and the wire is at right angles to it, the shadow thrown on the paper is that of a minute quadrilateral. Now, this little quadrilateral, a mere speck, vibrates back and forth, throwing its shadows on the moving plate, the successive vibrations corresponding to the particular cardiac muscle that contracts. The greatest contraction, which is that of the ventricles, forms the high notch in the tracing; the smaller notch that precedes the bigger one is the contraction of the auricles. The tracing does not distinguish between the right and left ventricles, or right and left auricles, but records the sum of the contractions of the two ventricles and two auricles. These are the main characteristics of every tracing. There are subordinate notches to be described later.

The electromagnets, constituting the north and south poles, are fed by an accumulator battery of about 10 volts, which is a necessary part of the outfit. The principle on which the galvanometer works is that an electric conductor actuated by a current placed in a magnetic field at right angles to the magnetic current oscillates forward and backward, according as the current is ascending or descending, as with the oscillating current of the street supply. The amount of oscillation depends on the strength of the magnetic field, the strength of the street current and the resistance.

But besides the accumulator battery, the machine requires a "null" apparatus. For when the hands or arms or feet are immersed in salt water, a so-called "null" or body current develops, and it has to be eliminated or "compensated for" in some way. Accordingly on the table of the machine there is a "null" apparatus, or "condenser," which must be placed in the line of the electric current.

Another apparatus to be fitted to the table is an appliance for regulating the voltage or amperage. Wheatstone's bridge is also used in addition for estimating the resistance of the electrodes and the body of the patient.

In Fig. 19 is seen an Einthoven galvanometer (*J*), suspended between the poles

of 2 electrodes. The electromagnets are wound with copper wire, and set in an iron frame (*IV*), supported on three adjustable feet. A microscope (*R*) pierces the axis of the magnets, and is illuminated by a lighting appliance (*C*). An apochromatic lens is fitted into the tube *R*, and another into the tube *C*. The first magnifies, and the second casts the shadow on the sensitive plate, operating through a narrow cleft which causes the shadow in the form of a minute right-angled speck to write on the plate as it vibrates back and forth. It is no easy matter to throw

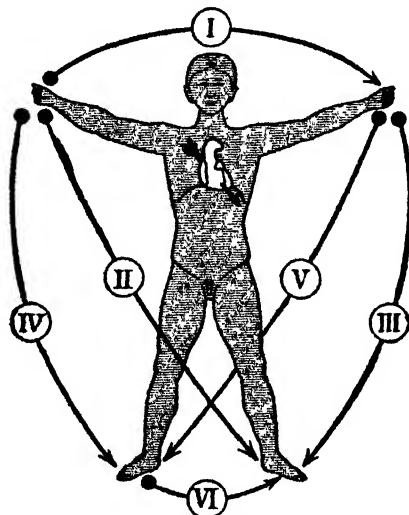


Fig. 21.—The six leads. (*Kraus and Nicolai.*)

the shadow on the paper. Careful adjustments have to be made of the micrometer screws (*L* and *Q*), so as to throw the shadow into the middle of the field, while the adjusting micrometers (*G* and *F*) have to be turned until all color defects have been eliminated. The plugs (*AA*) are used to shut off light currents of air, etc., that might disturb the electric currents.

In Fig. 20 there is seen at *L* an electric arc lamp, regulated by screws. At *W* is seen the water-bath used to absorb the heat rays of the lamp. At *G* is the galvanometer suspended between the poles of the magnets. Alongside of these are the accumulator batteries, while under the lamp and water-bath are the "null" apparatus and the apparatus for testing the sensitiveness of the galvanometer.



In the *Hindle electrocardiograph* (Fig. 22), the galvanometer has the shape of a horseshoe, with the ends separated by an interval of only  $\frac{1}{12}$  inch, through which the galvanometer string passes. *SC* is the string carrier, the string being housed above and below the horseshoe. Light from the lamp, *L*, illuminates the string, upon which it is condensed by a lens. The shadow of the string is magnified by a projecting lens at

from which the required electrical adjustments are made. *B1* is the battery operating the timer, and *B2*, the battery which electrifies the galvanometer. *P* are the wires leading to the patient.

In place of immersion jars for the hands and left foot, electrodes consisting of curved sheets of German silver, enclosed in flannel bags wet with hot salt solution, are commonly used. These electrodes are

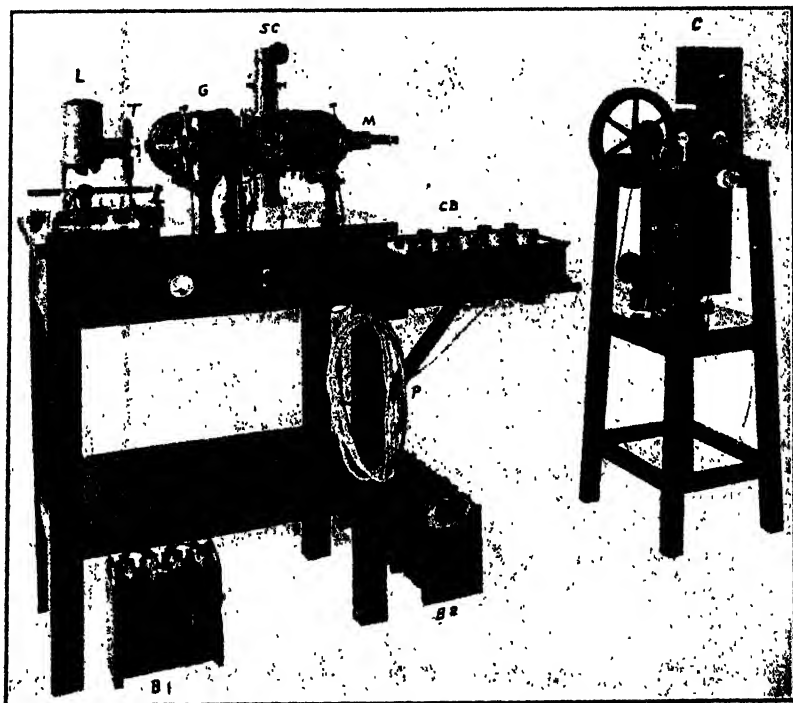


Fig. 22.—Hindle electrocardiograph, medium-sized model. (Talley.)

*M* and thrown upon the lens of the camera, *C*, on the other table. Film feeds past the lens from the upper box and then drops into the lower box, whence it can be removed for development. A time marker, *T*, consisting of a revolving spoked wheel controlled by a tuning fork below, marks off intervals of  $\frac{1}{4}$  and  $\frac{1}{25}$  second on the film by interrupting the light rays periodically. The round disc at *SC* is a wheel for adjustment of the tension of the string; this is necessary before each observation, and the adjustment sought is such as will be expressed in an excursion of 1 centimeter of the string shadow for every millivolt of current. At *CB* is the control board,

simply bound around the exposed forearms and left calf of the patient, who sits comfortably in an arm-chair. By means of connecting wires the curves can be made in a different building from that in which the patient is located.

Two kinds of curves may be made, either the black, prepared by developing the film and then taking prints from the latter, as in the usual procedure of photography, or the white, made by substitution of bromide paper for the film in the camera, the bromide paper being then developed and itself constituting the final record. The second procedure is less time-consuming, but the product does not lend itself to

multiple direct reproduction as from a film negative, and is not susceptible to correction of defects through the printing process as is the case when prints are made from a film.

Curves of the arterial or venous pulse, the respiration or the blood-pressure can be combined with an electrocardiogram by arranging a suitable lever, actuated by a tambour, in front of the camera. A second string carrier is, moreover, obtainable with the Cambridge electrocardiograph, whereby, with the aid of a microphone, synchronous curves of the electric variations of the heart and the heart sounds can be prepared.

The course of the electric current generated in the muscles of the cardiac chambers is much like that of the currents that pass over the surface of the heart, as to direction. We know that the left ventricle and right auricle are the heart chambers nearest to the surface of the body, and we also know by animal experimentation that the current through both arms is quite like the current emanating from these two points in the heart.

The electrocardiogram is, of course, subject to variations depending on age and the position of the heart. Each individual, indeed, has a rather distinctive electrogram.

**CLINICAL SCOPE OF ELECTROCARDIOGRAPHY.**—The electrocardiogram depicts the precise nature of the heart's contractions more completely than any other method. As stated by Lewis, galvanometric examinations of the heart give indications of thickening of the walls of one or another of the cardiac chambers. They locate small lesions in the cardiac muscle. They indicate when the impulse originates at the normal center, and, within certain limits, tell where new or heterogeneous impulses originate. They record separately auricular and ventricular contractions, and define the time relation of one to the other. They demonstrate the functional activity of the auriculoventricular bundle and

its branches, and distinguish slow from fast rates of the pulse. From the data obtained much information is secured as to the condition of the heart muscle.

The electrocardiograph does not permit us to dispense with the personal examination of the patient. Hence, a complete diagnosis can not be made by the instrument when the patient and the physician are far apart. Neither the electrographic machine nor any other instrument of so-called precision tells an invariably truthful story. Mechanical difficulties will at times occur, making the picture untruthful. The electrocardiograph is, however, capable of showing the time and force of action of ventricles and auricles, notes lack of transmission, and demonstrates ventricular and auricular extrasystoles more clearly than any other method. It is useful in various forms of arrhythmias, particularly when there is more or less complete auriculoventricular dissociation. It has greatly broadened the knowledge obtained by other graphic procedures.

**THE NORMAL ELECTROCARDIOGRAM.**—In Fig. 21 the course of the currents that may be used in electrocardiography is shown. Thus, in *I*, the course of the current is from the right hand to the left hand; in *II*, from the right hand to the left foot; in *III*, from the left hand to the left foot, and so on. The course of a current is called a "lead." The first 3 leads are those clinically employed; each of these will at times give information not supplied by the other 2. Lead *II*, however, is, on the whole, the most important. In a general way, Lead *I* records the waves as they occur at the base of the heart; Lead *II*, on its right side, and Lead *III*, on its left side.

The normal curve of the electrocardiogram in the 3 leads is shown in Fig. 23. Each cardiac cycle may be taken as beginning with the small, rounded wave *P*, which

represents the electric variation attending contraction of the auricles. The further 4 characteristic waves are designated by the 4 succeeding letters of the alphabet; thus, *P, Q, R, S, T*. The extensive wave *R* is believed to reflect the spread of the excitation wave at the base of the ventricles. Its apex is synchronous with the first heart sound. The *Q* wave, a slight downstroke immediately preceding the upstroke of *R*, and the *S* wave, a similar downstroke marking the termination of *R*, are ascribed to activity at the apical portions of the ventricles. They are less important than

wave in Lead *II* generally has a height of 1 to 2 cm. (2 to 4 wide spaces between the horizontal lines), and its duration from *Q* to *S* (*Q-R-S* interval) should not normally exceed  $\frac{1}{10}$  second. The *P-R* interval, i.e., the interval between the beginning of *P* and the first part of the upstroke of *R*, marks the interval between the start of the auricular excitation wave and that of the ventricular excitation wave, and is normally  $\frac{12}{100}$  to  $\frac{18}{100}$  second, with  $\frac{2}{10}$  as maximum. The *T* wave is frequently enhanced by exercise, becomes flatter with age, and may be flattened or inverted by digitalis.

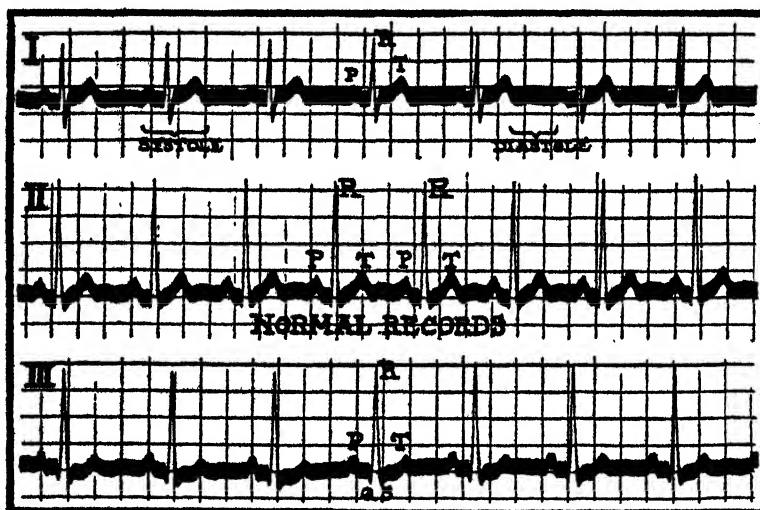


Fig. 23.—The normal electrocardiogram. (S. CALVIN SMITH, in *Annals of Clin. Medicine*.)

*P*, *R* and *T*, and are frequently absent in the normal electrocardiogram. The *T* wave rises and falls slowly a short period after the *R* wave. It varies considerably in extent in the normal curve, and is thought to represent the final phase of the ventricular contraction, the second heart-sound being synchronous with the end of this wave. At times a trifling *U*, or 6th wave, is found ascending and descending during the diastolic period; its significance is unknown.

An ascending wave is termed "positive"; a descending wave "negative." The *P* wave normally does not exceed 2 mm. in height, nor  $\frac{3}{100}$  second in duration. (The large time intervals, marked by the vertical lines on the ordinary tracing, measure  $\frac{1}{4}$  second, and the shorter intervals, marked by lighter lines closer together,  $\frac{1}{25}$  second). The *R*

The horizontal line of the curve, recorded during diastole and other portions of the cycle in which no current is passing, is known as the "iso-electric line."

The *P* wave, while always positive, i.e., directed upward, under normal conditions in Leads *I* and *II*, may be inverted (i.e., negative, directed downward) in Lead *III* without abnormality. *R* is normally always directed upward in all leads, and attains its greatest height in Lead *II*. *T*, while normally always directed upward in Lead *II*, and generally so in Lead *I*, may be inverted in Lead *III* without abnormality. Inversion of *T* in Lead *II* is prognostically unfavorable. As for the *Q* wave in Lead *I*, it is regarded as dependent upon activity of the right ventricle, and in Lead *III*, of the left ventricle. The *S* wave similarly de-

pend upon the right ventricle in Lead *I*, while the *R* wave in this lead relates to the left ventricle. Notches in *R* and *S* sometimes occur under normal conditions.

In general, all electrocardiographic curves deviating distinctly from the normal imply an abnormal course of the excitation wave in the heart, arising either from ectopic origin or from improper distribution of the impulse wave. On the other hand, a normal electrocardiogram does not prove that the heart is normal. Thus, electrocardiography is by no means to be conceived of as a procedure which will bring to light all pathologic states of the heart, but chiefly, though not wholly, as one which supplies information on the origin and distribution of the contractile impulse.

**VENTRICULAR PREPONDERANCE.**—The electrocardiogram yields data on the relative size of the right and left ventricles. Preponderance of one ventricle over the other, whereby the usual ratio between the 2 ventricles is disturbed, is marked by an inversion of the *Q-R-S* group, *i.e.*, the tall spike normally designated as *R* is directed downward instead of upward. If this inversion occurs in Lead *I* there is right ventricular preponderance, while if it occurs in Lead *III* there is left ventricular preponderance. Inversion in Lead *II* may coexist in either instance; or, there may be a prolongation of the downstroke of *R* below the isoelectric line, an unusual prominence of *S* resulting. In early infancy right ventricular preponderance exists physiologically, while at the other extreme of life there is a tendency to preponderance of the left ventricle because of the increased power required from this structure to pump the blood through the increasingly rigid peripheral vessels.

Advanced mitral stenosis and pulmonary obstruction are, as might be expected, typically attended with right ventricular preponderance. The *P* wave, representing auricular contraction, is also apt to be unusually high or notched in mitral stenosis. Where, however, there is a renal element associated with mitral stenosis, or when failure of the right ventricle occurs, the right ventricular preponderance may be lost and even replaced by a left-sided preponderance.

In aortic disease and in high blood-pressure there is commonly found a left ventricular preponderance. In such cases the *T* wave agrees in direction with the ventricular spike in both Leads *I* and *III*.

### CARDIAC ARRHYTHMIAS.

**Sinus Arrhythmia.**—To this disturbance I have also given the name **pneumogastric arrhythmia**, because of its close relation to pneumogastric influences. It was described by Kussmaul years ago, and has been called *vagus*, *fundamental*, *sinus*, *normal*, or *respiratory arrhythmia*. The word *sinus* implies that it is a variety of the rhythm that originates in the sinus venosus. It is a variation from the standard cycle within physiological bounds. Though the cardiac cycle varies in length, the systolic phase is little altered comparatively, while the diastolic is considerably lengthened.

It may be seen in a tracing of the radial pulse immediately after the apneic period of the Cheyne-Stokes respiration of uremia. Kussmaul called it the **pulsus paradoxus**. It is the pulse following a deep inspiration; hence the term "*respiratory*." It can also be caused by the act of swallowing, which is largely regulated by the *vagus* or pneumogastric; hence the term **pneumogastric arrhythmia**. It can usually be inhibited by one dose of **atropine**,  $\frac{1}{60}$  grain (0.001 Gm.). It also disappears under exercise or amyl nitrite.

The respiratory type of sinus arrhythmia is very common during the first 10 years of life and also at puberty. It may persist later, but more especially in persons whose nervous system is unstable. Deep breathing enhances the irregularity.

Graphic methods are of less diagnostic import in this form of arrhythmia than in

most others, as they show merely an intermittent lengthening of the diastolic period, without any especial changes in the form of the waves. The condition may be recognized by the finger on the pulse.

**Premature Contractions or Extrasystoles.**—In extrasystolic arrhythmia there are extra—that is, as it were, supernumerary—contractions, from stimuli that do not originate in the sinus, though in the main the regular or sinus rhythm is maintained. They are of three principal types: the *ventricular*, where the contraction originates in the ventricle; the *auricular*, where it originates in the auricle, and the *nodal* or *auriculo-ventricular*, where it originates in the junctional tissues.

If for any cause the left ventricle fails to empty, the residual blood, acting as a stimulus, can make the ventricle put in an extra beat before the normal auricular stimulus has passed down to it. On the other hand, in dilatation of the auricle, as, for example, in advanced mitral stenosis, the incomplete expulsion of the blood into the ventricle may operate to produce a supplementary contraction, which would then be an auricular extrasystole. Strain of auricle or ventricle may also probably produce premature contractions.

All extrasystoles are followed by a pulse period that is rather longer than the normal. They occur at regular or irregular intervals. They are illustrations of an abnormal irritability of the heart, and are most common in persons of a neurotic constitution.

Sometimes extrasystoles cannot be detected by the finger, but they are usually recognized upon auscultation, when the regular sequence of beats is occasionally interrupted by one or two short sounds

followed by a brief pause. To make them distinct, the patient should be told to run round the room a few times and then hold his breath. The extrasystoles are intensified by hurried movements.

When, in a *radial pulse tracing*, it is noted that the length of the pulse period preceding the extrasystole, together with the pulse period following, constitutes a length of two ordinary pulse periods, this is taken to mean that the extrasystole is ventricular. Auricular extrasystoles can be seen in *jugular tracings*. A characteristic of auricular extrasystole is that in the arteriogram the compensatory pause following is shorter than in the ventricular extrasystole.

The *electrocardiograph* not only differentiates precisely the auricular, ventricular and nodal forms of premature contraction, but also, in the ventricular form, separates premature contractions arising in the left ventricle from those arising in the right ventricle.

*Auricular* extrasystole is characterized (see Fig. 3, Plate I) by a premature *P* wave (*P*<sup>1</sup> in the illustration). This premature *P* wave is sometimes exaggerated, broad, inverted or coalescent with the *T* wave of the preceding cycle. The *R* wave succeeding the premature *P* is generally not changed in direction or shape.

In *nodal* extrasystole, a rare and usually transient condition, the stimulus to contraction travels upward to the auricle and downward to the ventricle. The auricle and ventricle may contract simultaneously, or the beginning of ventricular contraction may follow or precede that of auricular contraction. In the electrocardiogram the premature *P* wave may be inverted (*P*<sup>1</sup> in Fig. 4, Plate I), the wave of auricular contraction having been reversed; or, the *P* wave may coalesce with the *R* wave (*e.g.*, form a notch in its descending stroke) or actually follow it. In either instance the *R* wave, while premature, generally preserves an approximately normal shape. (Where all the contractions assume the form of nodal extrasystoles through permanent displacement of the sino-auricular node by the atrio-ventricular node as the source of the contractile impulse, the condition is termed *nodal rhythm*).

In *ventricular* extrasystole, which is the commonest form of the three, the auricular

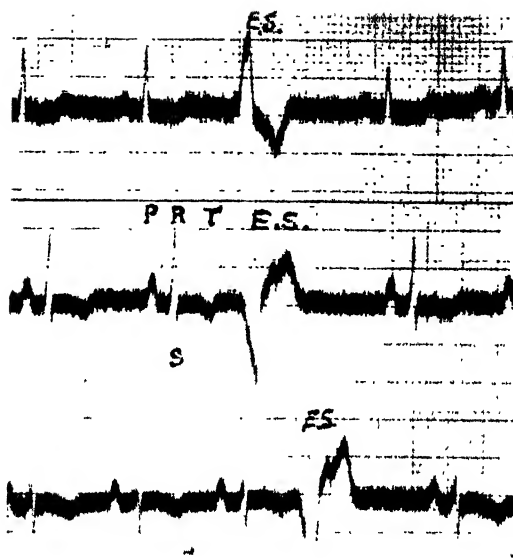


FIG. 1.  
Left ventricular extrasystole.

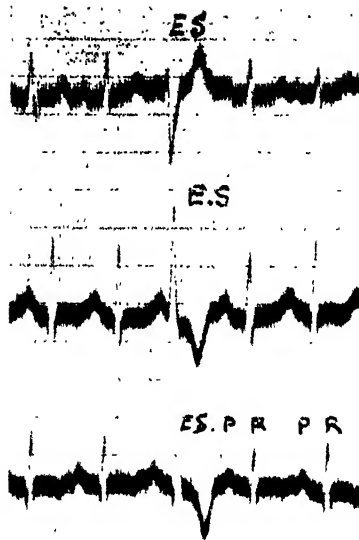


FIG. 2.  
Right ventricular extrasystole.

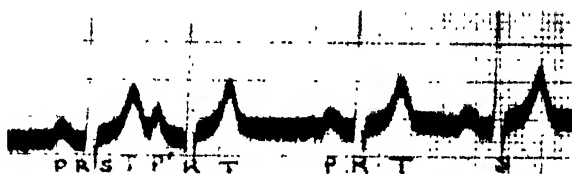


FIG. 3.  
Auricular extrasystole.

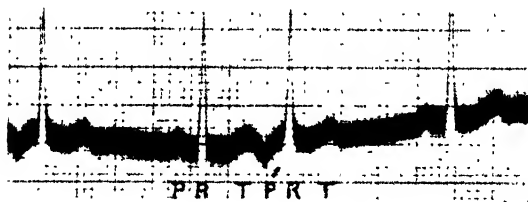


FIG. 4.  
Nodal extrasystole.

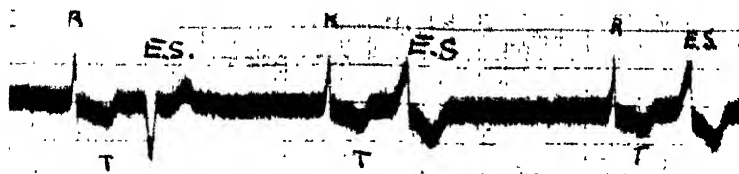


FIG. 5.  
Auricular fibrillation showing a coupled rhythm, the second beat being  
a ventricular extrasystole.



contractions are unaffected and recur in normal, equidistant fashion in response to the ordinary sinus impulses, although in the electrocardiographic record they are often submerged in the premature ventricular waves. The essential feature in the record is a premature ventricular complex (*Q-R-S-T* wave-group) which is distorted. Thus, in Fig. 1, Plate I, the initial stroke of *R* in the extrasystole (*E.S.*) is seen to be larger and of greater duration than normally, and is followed immediately by a large deflection having a direction opposite to the normal. The ectopic stimulus arising in the ventricle takes longer to excite the whole of the two ventricles to contract. The *P* wave is submerged in the large ventricular complex because the latter has preceded it. The premature contraction is followed by a pause of such duration as to compensate exactly for the brevity of the diastole that preceded the premature beat. That the extrasystole arises in the left ventricle in Fig. 1 is indicated by the downward direction of the ventricular complex in Lead *III*, whereas in Fig. 2, a record of right ventricular extrasystole, there is downward direction of the complex in Lead *I*, with upward direction in Lead *III*. The condition found in Lead *II* has also been regarded as significant in this connection, inversion of *R* in this lead pointing to a left ventricular disturbance. At times the electrocardiographic picture of alternating left and right ventricular extrasystoles is witnessed.

### THE FREQUENT PULSE.

The frequent pulse may be physiologic or pathologic. If merely the accompaniment of, or sequel to, violent exertion, in which the heart is called on for increased energy, within normal bounds, it is physiologic.

Experiments on animals show that irritation of the accelerator nerves increases the pulse rate. Similarly, section of the pneumogastric, or injury to its nucleus, increases the pulse rate to 150 a minute or over. It produces the continuously frequent pulse. On the other hand, pressure

on the pneumogastric will, in some persons, arrest a frequent pulse.

The full list of causes of tachycardia, as given by Larcena, is as follows:—

1. *Tachycardia in diseases of the heart and blood-vessels.* Under this head is included the increased action of the heart which occurs in overstrain, acute and chronic myocarditis, valvular diseases, pericarditis, angina pectoris, acute and chronic aortitis, arteriosclerosis, and the affections of the heart that attend Bright's disease.

2. *Febrile tachycardia.*

3. *Tachycardia from peripheral compression*—that is, on one or both trunks of the vagus—and *from central compression* of its nucleus.

4. *Tachycardia from organic disease of the nervous system.*

5. *Tachycardia in general diseases:* (a) Acute diseases, such as typhoid fever, diphtheria; (b) chronic diseases, such as tuberculosis, carcinoma, chlorosis, syphilis, chronic malaria, chronic rheumatism of the joints; (c) convalescence and exhaustion.

6. *Tachycardia* (a) from alcohol, coffee, or tea, and (b) from drugs such as digitalis, atropine, thyroid, etc.

7. *Reflex tachycardia* from the brain, heart, lungs, stomach, liver, intestines, uterus, abdomen, bladder, prostate gland, brachial plexus.

8. *Tachycardia in neuroses:* Graves's disease, hysteria, neurasthenia, epilepsy.

To which must be added:—

9. *Tachycardia* from irritation of the substance of the heart and its ganglia, or occlusion, partial or complete, of the coronary arteries.

10. *Tachycardia* from focal infections.

**Simple Tachycardia.**—This is the form of heart acceleration occurring as a result of emotion, exercise, fever, functional nervous disorders, hyperthyroidism, the menopause, infections or alcoholism. The tachycardia is likely to be reducible by recumbency, seldom exceeds a rate of 150, and begins and terminates in a gradual manner, in contrast to that which ob-



tains in paroxysmal tachycardia. As the origin of the contractile impulse is in the sinus, as normally, graphic studies reveal no abnormality other than the unusual frequency.

A permanent form of simple tachycardia is frequently seen in chronic tuberculosis, in which there may be no considerable rise of temperature, or in tertiary syphilis with pulmonary complications. This latter form of frequent pulse continues to the end of life.

**Paroxysmal Tachycardia.**—Examples of the paroxysmal form are seen in neurasthenic states, in which there is a sudden frequency of the pulse and a cessation of tachycardia, the attack lasting a few seconds, minutes, hours, days, or even weeks, and sometimes leaving the patient exhausted and occasionally with a dilated heart.

In paroxysmal tachycardia the pulse is usually small and compressible, due probably to imperfect filling of the vessels. In 30 cases given by Martius it ranged from 80 to 180, the average being from 120 to 140. The limits have also been set at 110 to 220, the latter rate being one at which the ventricle has difficulty in following the pace set for it from the auricle. The rate changes little or not at all upon rising from recumbency or *vice versa*.

The condition may occur in childhood, middle age, or advanced years. Broadbent recorded a case at 81 years.

In the paroxysmally frequent pulse the symptoms vary. Almost all of the patients are anxious and complain of lassitude. There is often precordial oppression. Some patients are cyanotic, others are not. Some

attend to business as usual. The lungs are usually free, although, according to Riegel and Martius, there have been noted instances of pulmonary emphysema which appeared with the frequent pulse and disappeared with it. Among other signs that have been noted are cardiac dilatation, venous thromboses, swelling and pulsation of the veins of the neck, albuminuria, edema, ascites and delirium.

The *electrocardiograph* reveals that the origin of the rapid rhythm is usually a point other than the sinoauricular node, *viz.*, a point either auricular, ventricular, or in the atrioventricular node. The paroxysm is likely to be preceded or followed by a few premature contractions, from the records of which the point of origin of the tachycardia may be discerned more readily than from the record of the paroxysm itself. Yet in paroxysmal tachycardia of *auricular* origin the *P* wave may be seen during the actual attack to be inverted or combined with the preceding *T* wave, while the *R* wave is likely to be of normal character. On the other hand, in tachycardia of *ventricular* source there is distortion of the *R* wave, as in ventricular extrasystole, and the *P* wave may fall within and be obscured by the *R* wave. In paroxysmal tachycardia of *nodal* origin, as in the auricular form, inversion of the *P* wave may be present. As a matter of fact, the electrocardiogram reveals paroxysmal tachycardia to be essentially a more or less protracted series of immediately successive premature contractions.

There is much to learn in the matter of treatment. As, however, **pressure** on the **pneumogastric** nerve will reduce pulse frequency, it has been tried, and with temporary success. **Iced water** and **strong coffee** have sometimes been effective; so have **Hoffmann's anodyne** and **diffusible** and **alcoholic stimulants**. Thomson, in a record of 6 cases of tachycardia associated with various forms of neurasthenia, ascribed the disease to

gastrointestinal intoxication, and had success with strontium salicylate in 15-grain (1 Gm.) doses, weak mercurials, intestinal antiseptics, and a carefully regulated diet, which excluded highly nitrogenous food. On the other hand, when the frequent pulse is reflex, so that we can ascribe it to non-toxic diseases of the stomach, kidneys, ovaries, uterus, or other organ of the abdominal or pelvic

distress, and it may not be inconsistent with a fairly active life.

**Abdominal compression** by a tight flannel binder (W. Gordon) may be successful in some cases.

The prognosis, as a rule, is unfavorable in the cases with rapidly repeated, prolonged recurrences.

**Auricular Flutter.**—In this form of arrhythmia the rate of auricular contraction is often 300 or more, the ex-

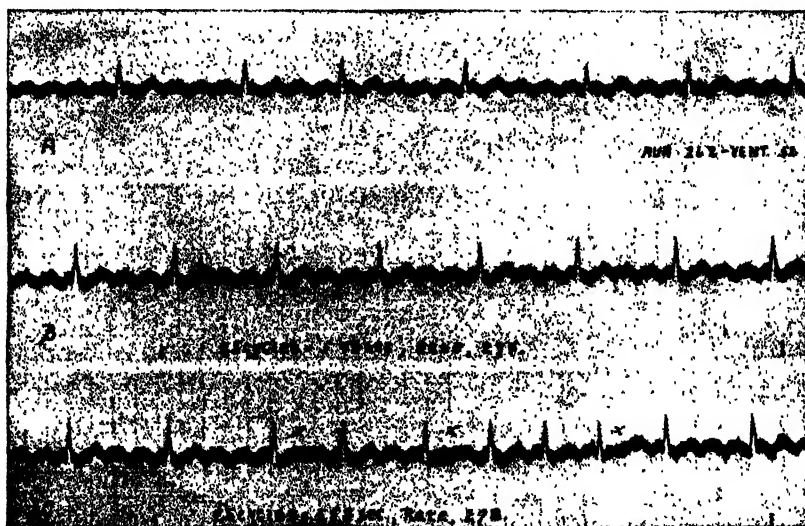


Fig. 24.—Auricular flutter (A). B and C are continuous records after exhibition of atropine. C shows impure flutter at x. (WEDD, in *Annals of Clin. Medicine*.)

cavity, it may be due to arterial hypertension (Huchard), or to vasomotor paresis

In the permanently afebrile frequent pulse it may be impossible to reduce the pulse rate materially; but we must always keep in mind that it is merely a symptom, and not necessarily a distressing one.

If, however, the constitutional affection, be it tuberculosis, syphilis, or any exhausting disease, improves, the pulse will fall at a rate corresponding to the improvement. A rate of 120 to 130 does not necessarily produce

treme range being from about 230 to 350. The source of the extremely frequent stimuli appears to lie in the "circus movement," viz., an excitation wave following a circular course in the auricle, generally around the mouths of the venæ cavæ. Circuits are made at the rates per minute already referred to, and each circuit excites an auricular contraction which would be followed as usual by a ventricular contraction were it not that (1) the ventricles have difficulty in contracting at so high a rate; (2) the extremely high auricular rate seems

in itself to cause a depression of conduction which prevents the ventricles from responding even by the highest rate of which they are capable. In consequence, 2:1 heart block is a common accompaniment of flutter, the ventricular rate being  $\frac{1}{2}$  the auricular. Less frequently, a 3:1 or 4:1 block, or even complete dissociation, may be observed. Occasionally a 1:1 ratio is recorded.

Flutter may be suspected clinically where the ventricular rate remains persistently at from 130 to 160 and is not affected by exercise, rest or change of posture. From paroxysmal tachycardia it may be distinguished by its longer duration, the somewhat lower ventricular rate, and the relative absence of impaired cardiac function.

A positive diagnosis of flutter is reached from the electrocardiogram, although the polygram alone may be significant, a number of small, regular wavelets appearing in the curve from the jugular vein. In the electrocardiogram the auricular *P* waves succeed one another regularly at a high rate, while the ventricular complexes occur less frequently, usually exhibiting a 2:1 or 3:1 block, with a rate correspondingly lower than the auricular. The ventricular contractions, while often regular, may be irregular; *e.g.*, there may be alternation of a 2:1 and a 3:1 ratio. Where there is complete block, the ventricular rate may fall to the vicinity of 36 per minute.

A state of "impure flutter" is sometimes spoken of, in which the auricular movements are less regular than in typical flutter, thus approximating those of auricular fibrillation, yet the auricular muscle contracts in fairly large masses, so that typical fibrillation cannot be said to be present. In such instances the record presents in diastole a coarsely wavy, but irregular line.

**Auricular Fibrillation.**—This disturbance was formerly called nodal rhythm by Mackenzie, and is one

cause of the **permanently irregular pulse** of Hering. Here the cardiac cycles vary so much that there is no sequence of beats having the same length.

In fibrillation there seems to arise in the auricle a continuous shower of stimuli, which, falling on the node, excite it to send stimuli to the ventricle as rapidly as the bundle (and so the ventricle) is capable of taking them up. The apparent shower of stimuli is ascribed, as in auricular flutter, to circus movements in the auricle. The two conditions differ, however, in that, whereas in flutter the excitation wave flows continuously and regularly in a single circuit, in fibrillation the wave follows an ever-varying route, with the result that the further propagation of the wave takes place irregularly and there are dispatched toward the ventricles not only frequent, but also irregular, stimuli.

If the ventricle can be made to beat more slowly, the patient may often lead a useful and even vigorous life for some years. It is therefore very important to diminish the rate, and this is done in a remarkable manner by **digitalis**. The gravest sign is an increase in rate; say, from 100 to 150. The digitalis should then be pushed until there is a fall to 80.

Auricular fibrillation constitutes a considerable percentage of all irregularities. The ventricular rate may be reduced as low as 30, or increased as high as 200. With the higher rates, many beats of the heart may not reach the radial artery, in which event there is said to be present a **pulse deficit**. Rates of 110 to 150 are the commonest, and with these high rates the irregularity is greatest.

CARDIAC

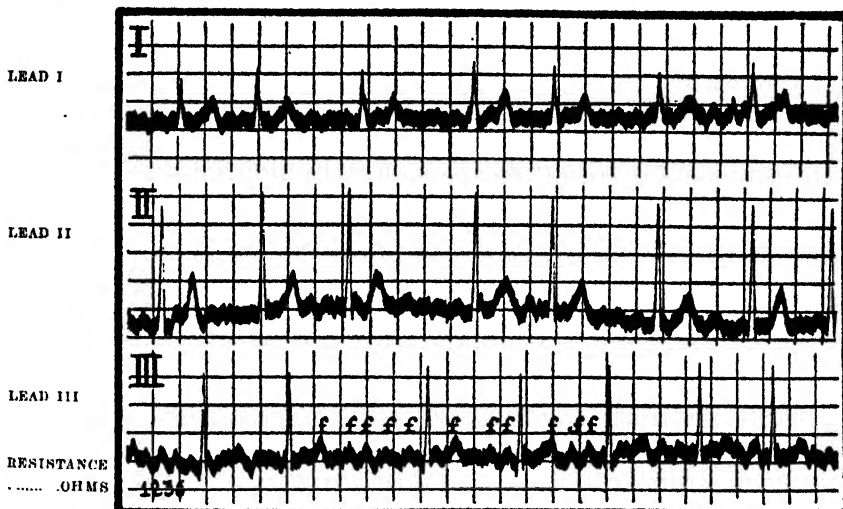
RECORD NO. ....

**ELECTROCARDIOGRAPHIC STUDY**

DATE .....

NAME ..... ADDRESS .....

REFERRED BY ..... ADDRESS .....

FILM NO. 1236 CIRCUMSTANCE *PATIENT DYSPNEIC AFTER REMOVING CLOTHING.***ANALYSIS OF ABOVE RECORDS**

AURICULAR RATE per minute.....Not determinable.

VENTRICULAR RATE per minute.....Averages 75.

RHYTHM .....Utterly disordered.

CONDUCTION TIME FROM

AURICLE TO VENTRICLE.....As there is no auricular wave, the conduction time from auricle to ventricle cannot be estimated.

DEPARTURES FROM NORMAL	{	LEAD I .....P wave absent.
		LEAD II .....P wave absent.
		LEAD III.....P wave absent.

GRAPHIC INTERPRETATION

OF THE ABOVE RECORDS .....AURICULAR FIBRILLATION.

**LEGEND.**—The regularly recurring and definitely formed auricular wave P is absent in all three Leads, and coarse fibrillary waves fill diastole. Note the absolutely irregular spacing of the tall R spikes, which are the representatives of ventricular activity.

**Fig. 25.**—Electrocardiographic study of a case of auricular fibrillation.  
(S. CALVIN SMITH, in *Annals of Clin. Medicine*.)

In many instances a diagnosis of auricular fibrillation can be made without instrumental aid. Significant features are: A persistent irregularity with a rate exceeding 120, coupled with evidences of cardiac failure; an extremely irregular pulse, with wide variation of pulse amplitude; irregular heart-action on auscultation, with inability of some of the audible contractions to propel blood to the wrist, and even absence of the second heart sound owing to inability of certain feeble contractions to open the aortic valve; the presence of mitral stenosis; increase of the irregularity upon increase of rate by exercise or inhalation of amyl nitrite. Instrumental aid for diagnosis is more likely to be necessary where the rate is relatively slow.

In the *polygram* the *a* waves are absent from the jugular curve because no contractions of the right auricle are taking place; there may, however, be noticed, where the rate is slow, some small, rapid oscillations during the prolonged diastole, as an evidence of the fibrillation. The curve from the radial artery shows a completely irregular succession of strong and weak beats, which are frequently dicrotic, with uneven duration of the pauses between beats, and lack of correspondence between the strength of individual beats and the duration of the preceding pauses. In the vast majority of instances a sphygmogram showing that no two successive heart beats are of the same length implies the diagnosis of auricular fibrillation.

In the *electrocardiogram* the three essential features of auricular fibrillation are the same as those of the polygram: (1) Absence of the auricular wave, the *P* wave being wanting in all three leads; (2) completely irregular intervals between the ventricular (*R*) waves; (3) numerous small oscillations (*f* waves) during diastole, representing the twitchings of the auricle. The *f* waves are best seen in Leads II and III. At times they are relatively inconspicuous, especially where the ventricular rate is high. As in the polygram, it may be noticed that the height of the *R* spikes bears no relationship to the duration of the pauses preceding ventricular contraction. Sometimes the *T* wave is flattened, inverted, or distorted by the *f* waves.

Not infrequently the records of auricular

fibrillation are complicated by ventricular premature beats (see Fig. 5, Plate I), branch bundle block or the evidences of preponderance of one ventricle over the other. If complete heart block complicates auricular fibrillation, the idioventricular rate, *i.e.*, the rate of the ventricles as they beat independently of stimuli from above, is sometimes higher than is usual when fibrillation is not present. Instead of being below 40, it may be 60 or even higher.

When digitalis is given in excess of tolerance in auricular fibrillation, there is a tendency to the appearance of ventricular extrasystoles and coupling of the beats.

**Ventricular Fibrillation.**—Lewis demonstrated, by the use of the electrocardiograph in association with the myograph, that there may be ventricular as well as auricular fibrillation. In experiments in dogs ventricular fibrillation was induced by irritating a papillary muscle, the central surface of the right ventricle, or its lower angle. Chloroform anesthesia was also found to produce ventricular fibrillation in cats (Lewis and Levy), followed by heart-failure. Intravenous injection of adrenalin chloride had the same result, if the anesthesia was light, but under deep anesthesia it was less dangerous.

Ventricular fibrillation may be shown graphically with the electrocardiograph. It is not long consistent with life.

### THE INFREQUENT PULSE.

The words *bradycardia* (introduced by Grob), *spanocardia*, *araiocardia*, and *oligocardia* (kardios, heart; brados, slow; spanos, deficient; araios, rare; oligos, few) have been applied to the infrequent pulse, but to my mind, of all the terms suggested no one expresses the numerical deficiency of pulse beats to the minute so well as the term, *the infrequent pulse*.

The pulse rate, as is well known, varies more or less according to circumstances, such as the age and height of the individual, atmospheric temperature, the time of day, and acquired or inherited peculiarities. In the adult male the standard is set

at 72; in the adult female at 76 to 80. Large individuals have a slower rate than small ones, and, while the average rate at birth is set at 140, it falls gradually toward 70 in senility, rising again gradually toward 80 in extreme old age. Also, as blood-pressure in the arteries falls, the pulse rate rises, while as the pressure increases the rate falls. In some alterations of the blood, as in asphyxia, where the  $\text{CO}_2$  content rises, the pulse rate first increases and then decreases as soon as toxic symptoms supervene (Howell). These facts should always be borne in mind in estimating the significance of a high or low pulse rate. And yet it is by no means rare for a person in apparently good health to have a pulse anywhere in the sixties. By general consent, however, a pulse below 60 is to be regarded as an infrequent pulse.

The infrequent pulse may occur at almost any period of life. Prentiss reported 1 instance at 16 months. In my experience it has occurred oftenest in the middle period of life or after it. According to Grob's (82 in 3578 patients) statistics, about 1 individual in 40 has an infrequent pulse. It is unfortunate, however, that observers have often failed to note the relation in number per minute between the pulse and the heart beats, though the importance of ascertaining this variation was pointed out by Stokes ("On the Heart," etc., p. 329, 1855), in 1846, when he told of a patient whose heart beats were 36 to the minute, while the pulse was 28.

The infrequent pulse has two principal varieties, the physiologic and the pathologic.

Of the first we have two well-known instances, the infrequent pulse of inheritance and that of pregnancy. Prentiss recorded several instances of persons whose pulses averaged 30 to 32 and who were in apparently sound health, and historians tell us not only that Napoleon's pulse was 40 even in the midst of a battle, but that he felt uncomfortable when it rose to 60. The most remarkable instance, however, is that of Vigouroux, who had under observation a laborer whose pulse never exceeded 20. The modern view is that a simple infrequent pulse of 40 or below is rare, most of such cases being instances of heart block, even though in apparent health.

The infrequent pulse is more common in males than in females, the ratio being about 5 to 1, according to Prentiss's tables.

Of the pathologic infrequent pulse we have two subdivisions, the paroxysmal, periodic, or temporary, and the chronic. Under the causes of the former come infections, such as typhoid, diphtheria, pneumonia, erysipelas, puerperal infections, and influenza (best seen during convalescence); intoxications from lead, tobacco, tea, coffee, digitalis, uremia, jaundice, diabetes, hypothyroidism and syphilis; functional nervous disturbances, reflex influences from the skin or gastrointestinal tract, and temporary debility. Under the pathologic variety come also organic diseases of the brain or cord, or of the heart itself. It may be met with in chronic nephritis and high blood-pressure.

The paroxysmally infrequent pulse represented 112 of Grob's 140 cases. His experience that the paroxysmally

infrequent pulse largely predominates coincides with my own. Holbertson published a case in which the pulse fell on one occasion to  $7\frac{1}{2}$  in a patient who had attacks of vertigo and loss of consciousness following an accident on the hunting field. The post-mortem showed that there had been pressure on the medulla and upper part of the cord, due to fracture of the occipital bone and upper cervical vertebræ. Other instances have been recorded where the pulse fell as low as 4 and even 3 without a fatal result.

The paroxysmal cases may be due to reflex excitations of the pneumogastric, though the stimulus of almost any afferent (sympathetic) nerve (such, for example, as the abdominal sympathetic) may cause them, for a blow on the abdomen conveys the impulse to the medulla through the pneumogastric, slowing or stopping cardiac action. These attacks may also be due to depression of the augmentors, such as occurs in nervous or muscular strain, and in gastrointestinal irritation. They may also be caused by diminished action of the accelerators.

The upper and lower branches of the vagus unite in the heart with the sympathetic network so as to form the cardiac plexus, filaments from the vagus, however, terminating in the sinoauricular node.

Both vagus and sympathetic fibers are efferent in character, but there are also afferent filaments, carrying sensations away from the heart. Some of these are stimulated at each beat of the heart. These latter fibers may cause painful sensations, for the stimulated vagus may send radiations to various sensory nerves. The vagus affects both the rate and the force of cardiac contractions, and also conductivity. The familiar experiment of pressure on the vagus in the neck causes slower and stronger cardiac contractions, while if the

auricle is injured or pressed upon, permanent or temporary loss of conductivity is liable to follow. Indeed, experiments have shown that injury to the auricle or pressure on it may so disturb conductivity that upon several auricular contractions few or perhaps only one ventricular contraction may follow; in other words, there will be *heart block*. Direct stimulation of the vagus in lower animals may even keep the heart inhibited for several hours; or, the inhibition may be indirect, and due to a blow on the abdomen, or distention of the stomach or intestines by gas, this latter accident causing the heart to stop entirely. I have seen a case of complete temporary heart-failure of this kind in which the respiration also was suspended, so that death seemed to have taken place.

In the physiologically infrequent pulse, such as the hereditary, or congenital, or pulse of pregnancy, there are no untoward symptoms. In fact, evidence goes to show that in most of them, or certainly in many, an increase in rate begets disagreeable sensations.

On the other hand, the infrequent pulses of the infections, such as typhoid, and the toxic states, are wrapped up in the symptomatology of the disorders themselves.

In the treatment of the infrequent pulse no greater mistake can be committed than in aiming to accelerate the pulse by medication only. In the paroxysmal forms the prognosis depends on our success in mastering the disease of which it is a symptom, but when it is due to a functional nervous disturbance, or we are in doubt as to its exact cause, sedatives such as **monobromated camphor**, **asafetida**, **valerian**, and **Hoffmann's ether** are the remedies *par excellence*, together with **carbonated baths** and **resistance exercises**, carefully regulated diet, and observance of the sound rules of health.

**Heart Block.**—Much light was thrown on the infrequent pulse by the discovery of the auriculoventricular or His bundle, or Gaskell's bridge.

It has long been known that at an early period in embryonic life the heart is a tube, at one end of which is the sinus venosus, where the venous trunks unite (Fig. 26). From

auriculoventricular bundle, which unites auricle with ventricle. In the lower vertebrates the sinus venosus, auricular canal, and aortic bulb are still recognizable, but not so in the human species. The remains of this sinus, however, were discovered by Keith and Flack (*Jour. of Anat. and Phys.*, vol. xli, pp. 172-189), in 1897,

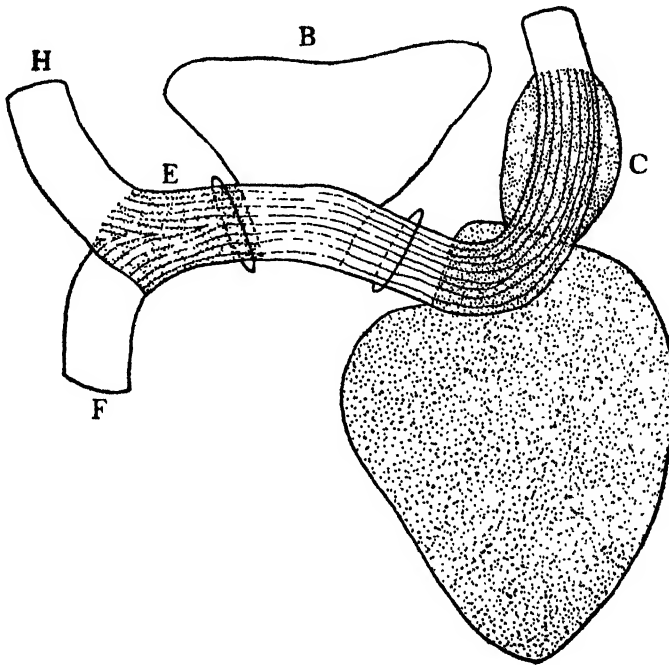


Fig. 26.—*D* is the primitive mammalian tube, indicated by longitudinal striations, extending from the sinus venosus (*E*), where the upper vena cava (*H*) and the lower vena cava (*F*) join, through the bulbus cordis (*C*) to the aorta. *B* is the primitive auricle and *D* the auricular portion of the primitive tube, or auricular canal. *A* is the ventricle. The bulbus cordis is eventually included in the human right ventricle. (Schematic representation after Keith.)

this tube pouches develop, to become, on the one hand, an auricle (*B*) and, on the other, a ventricle (*A*), while the original tube, the auricular canal, still connects them. Later, in connection with the sinus are formed the superior vena cava (*H*) and the inferior vena cava (*F*), a portion of the right auricle, and the coronary sinus. Eventually this primitive tube is converted into the His bundle or

and located at the mouths of the venæ cavæ. The sino-auricular node, from which the contractile impulses normally start, is situated at the junction of the superior vena cava and the right auricle.

Keith, His, and others had found the primitive tube (which eventually becomes the bundle) extending over from auricle to ventricle. At the head of the bundle of His stands a



node, the auriculoventricular node, first called, from its discoverer, Tawara's node ("Das Reizleitungssystem," Jena, 1908). It is situated in the wall of the right auricle, near the mouth of the coronary sinus.

From Tawara's node the bundle

terior part of this membrane the bundle divides into right and left branches. The *left branch* enters the left ventricle immediately beneath the center of the aortic valve, and courses down to the septum, where it arborizes, becoming continuous with the



Fig. 27.—Human heart, showing the origin, course, and distribution of the auriculoventricular (His) bundle. The anterior walls of the right ventricle and right auricle have been removed. The intra-auricular septum, the tricuspid valve, the papillary muscles (*G*), the moderator band (*F*), and the interior of the infundibulum (*H*) are exposed. *A* lies in the right auricular appendix, *B* in the fossa ovalis; *E* is placed beneath the mouth of the coronary sinus. Directly beneath *D* is a fan-shaped bit of muscle; a bristle has been placed beneath it. From this point the auriculoventricular bundle and its right branch are traced as they lie on five bristles between *D* and *F*. From a specimen in the possession of Keith. (Lewis, "Mechanism of the Heart Beat.")

runs at first almost horizontally forward and to the left, ensheathed in a fibrous canal, and it pursues its course directly to the right of the central fibrous body of the heart, as far as to the membranous part of the septum of the ventricle. At the an-

subendocardial network of Purkinje's fibers. Two main branches of it pass to the papillary muscles. The *right branch* of the bundle enters and follows the moderator band to the papillary muscles in the right ventricle, where its arborization begins, lead-

ing to the Purkinje fibers and these, in turn, to the muscle fibers of the ventricle.

The structure of the several divisions of this system varies considerably. At the auriculonodal junction the fibers are those of smooth muscle tissue, interspersed with connective tissue, nerve fibers, and ganglion cells. In their course the muscle fibers increase in size until they form networks, and finally take on the well-known character of Purkinje's fibers.

In affections of conductivity the stimulus may be delayed in its course, may not traverse the bundle at all, or may be arrested beyond it. Any one of these several conditions will produce **heart block**, a term invented by Gaskell, in 1882, to indicate arrest or blocking of the impulse normally conducted from auricle to ventricle.

The infrequent pulse is very apt to indicate impaired conduction.

Among the most frequent causes of reduced conduction are diseases such as rheumatic fever, diphtheria, typhoid fever, scarlet fever, pneumonia, septic infections and influenza. Pathologically, acute inflammation or degeneration of the conducting tissues may be found as the lesion responsible. As a rule, however, normal conduction returns with convalescence. Permanent heart block is oftenest due to severe or recurrent rheumatic fever and to syphilitic tissue disease or gumma. Fibrotic change in the heart in old age is also sometimes a cause. Occasionally, neoplasms, such as endothelioma, fibroma or sarcoma, have induced heart block. In several of my cases the condition has been due to hemorrhage at the base of the brain, when

pressure is brought to bear on the nucleus of the pneumogastric. Stimulation of the peripheral branches of the pneumogastric may also produce heart block; likewise, aconite, epinephrin, muscarine, physostigmine, digitalis, and asphyxia.

Several grades and forms of disturbed conduction are recognized:

1. *Delayed conduction*, in which there is prolongation of the interval between the start of auricular contraction and that of ventricular contraction.

2. *Dropped beats*, in which isolated ventricular contractions are completely absent.

3. *Partial heart block* of higher grade, in which the auricles beat regularly 2, 3 or even 4 times to every ventricular beat.

4. *Complete heart block*, in which there is complete auriculoventricular dissociation.

At times it is not the auriculoventricular node or bundle which is affected, but one of the main divisions of the bundle or the Purkinje network itself, leading to:

5. *Branch bundle block*, right or left.

6. *Arborization block*.

There may also occur:

7. *Sino-auricular block*, in which the defect of conduction is located high up, between the sino-auricular node and the main mass of the auricular muscle.

Dropped beats due to defective conduction may be distinguished without instrumental aid from intermittences due to extrasystolic arrhythmia by the absence of sound at the apex during the intermission, the ventricle having completely failed to contract. Exercise or amyl nitrite abolishes temporarily both dropped beats and extrasystoles, whereas in auricular fibrillation the irregularity will become worse. In 2:1

block with a ventricular rate of about 45, exercise or amyl nitrite will abruptly double the rate, which will then drop by  $\frac{1}{2}$  suddenly upon rest. If such a block co-exists with mitral stenosis, it may be possible to hear two presystolic murmurs to every ventricular contraction, the murmur being due to the auricle and consequently double in rate. In complete heart block, when only about 26 to 40 beats can be recognized at the wrist, inspection of the jugular vein will usually show that the auricular contractions are really twice or even more times as frequent. With the head turned to the left, the beating of the vein can be seen in a good light. In contrast, the slower beats of the carotid may be visible. An occasional extra large pulsation of the jugular may be noticeable as evidence that the auricle and ventricle contracted at the same moment. In complete block, moreover, the ventricular rate is little affected by exercise, amyl nitrite or atropine. At times further evidence in various grades of impaired conduction is obtainable by actually hearing the faint auricular systoles independently of the ventricular first sound.

In the *polygram* simple delayed conduction, which is seldom recognizable without instrumental means, is readily detected in prolongation of the *a-c* interval in the jugular curve, the period elapsing between the auricular and carotid waves exceeding the higher limit of normal, which is  $\frac{3}{10}$  second. Where there are dropped beats or a higher grade of partial heart block, the jugular curve shows an excess of *a* waves as compared to the *c* waves—the latter corresponding to the reduced number of pulsations shown in the radial curve. Occasional extra high waves in the jugular curve may result from practically simultaneous contractions of the auricle and ventricle. Regularity of the *a* waves is a feature which assists in the exclusion of certain other arrhythmias. In complete heart block (see Fig. 5, p. 310), there is a total lack of uniformity in the *a-c* intervals, and the radial pulsations, and correspondingly the *c* waves in the jugular curve, are even less numerous than in partial block, the ventricular rate being usually 40 or less.

In the *electrocardiogram* similar features are found. In delayed conduction the in-

terval between the *P* and *R* waves is increased from the normal  $\frac{1}{10}$ – $\frac{2}{10}$  second up to as much as  $\frac{3}{10}$  or even more. At times the auricular wave occurs so far in advance of the *R* wave that it encroaches on the *T* wave of the preceding cycle, a notched *T* wave resulting. In cases with single dropped beats, the ventricular complex after certain of the *P* waves is seen to be completely missing; frequently each miss is preceded by a succession of cycles in which the *P-R* interval grows progressively longer, until finally a cycle is reached in which *R* fails to occur. In the next grade of block, which patients may be observed to reach after having been through periods of impaired conduction of lesser grade, the commonest observations are a 2:1 block or an alternating 2:1 and 3:1 block (pure 3:1 and 4:1 being much less frequent). Here the electrocardiogram shows, *e.g.*, in the 2:1 block, regularly 2 *P* waves to every ventricular complex. In complete block, on the other hand, there are not only multiple *P* waves, but these waves no longer bear any regular time relationship to succeeding ventricular complexes, *i.e.*, the *P-R* intervals are altogether irregular (see Fig. 6, Plate II). Usually a considerable degree of regularity in the *P* waves and the much less frequent ventricular complexes is preserved, but there is no correspondence between the two rhythms.

**Branch bundle block** points to myocardial disease, at least in the vicinity of the affected branch of the bundle of His. The local fibrosis or vascular obliteration found histologically are usually the result of a general arteriosclerosis, rheumatic fever or syphilis. The condition can be definitely recognized only by the electrocardiograph; reduplication of the first heart sound, the only clinical evidence of it, is frequently not discernible. Right branch bundle block is far more common than left branch bundle block—a fact which has been ascribed to the greater distance traversed by the former branch before it subdivides. The curves of branch bundle block are characteristic, although in some respects similar to those of ventricular preponderance, the predominant ventricle in this case being that supplied by the intact branch bundle. The records in Leads I and III are the most significant, but Lead II brings further evi-



FIG. 6.  
Full heart block

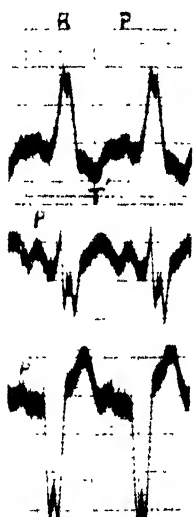


FIG. 7  
Right bundle branch  
block

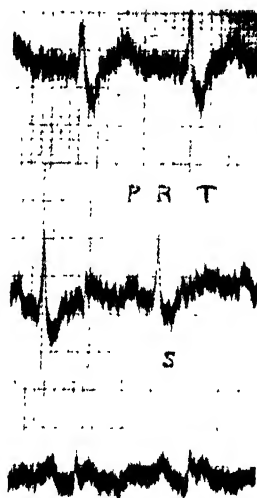


FIG. 8  
Incomplete bundle branch  
block.

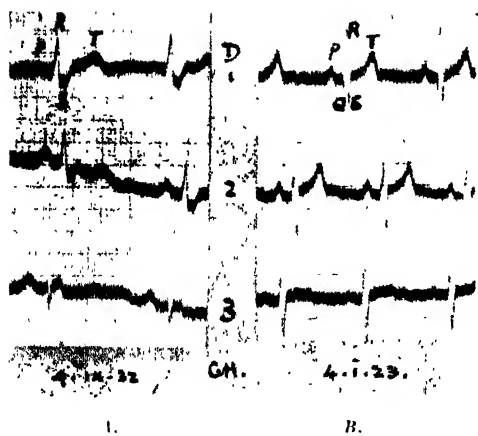


FIG. 9  
Changes in the electrocardiogram.

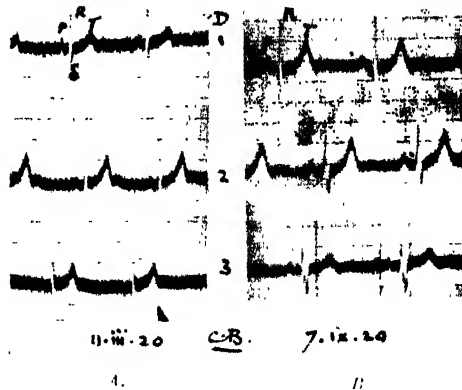


FIG. 10.  
Changes in the electrocardiogram.



dence by its usually bizarre form. A fundamental feature is that, because of the block in one branch, the corresponding ventricle receives its impulse only indirectly by propagation from the opposite ventricle. It contracts later than its fellow, and the *Q-R-S* group is therefore greatly broadened, with *R* presenting a broad, often notched summit (see Fig. 7, Plate II); or, one of the limbs of *R* may be notched or thickened. The direction of the ventricular spikes in Leads *I* and *III* varies according to which branch bundle is affected, and corresponds to what would be expected in the way of ventricular preponderance (*q.v.*); thus, in right branch bundle block the spike is directed upward in Lead *I* and downward in Lead *III*, betokening preponderance of the left ventricle, owing to block of conduction to the right ventricle. In the rarer left branch bundle block, the spike is directed downward in Lead *I* and upward in Lead *III*. Another peculiarity of the record of branch bundle block is that the *T* wave is opposite in direction to the preceding spike; thus, in Fig. 7, Plate II, *T*<sub>1</sub> is seen pointing downward in Lead *I*, while in Leads *II* and *III*, in which the ventricular spikes point downward, the *T* wave is directed upward. This peculiarity indicates impairment of conducting tissue, while excluding a simple ventricular preponderance as the cause of unusual direction of the ventricular spikes.

Confusion of the records of branch bundle block with the somewhat similar curves in ventricular extrasystoles (see Figs. 1 and 2, Plate I) is obviated by the regularity of rhythm in the former condition and the absence of disturbed relationship between the auricular and ventricular complexes. Polygraph tracings do not reveal branch bundle block.

The possibility of a temporary, functional form of branch bundle block; due, *e.g.*, to toxic influences, must be taken into account. As with the ordinary forms of heart block, branch bundle block may be incomplete, as illustrated in Fig. 8, Plate II, of which Cowan describes the principal features as a broad *S* with thickened ascending limb, a *Q-R-S* period measuring  $1\frac{1}{100}$ – $1\frac{1}{400}$  second, and in Lead *III*, a small *R* fading gradually into an inverted *T*—this being definite evidence of an organic myocardial lesion.

The symptoms of branch bundle block are merely those of cardiac insufficiency.

**Arborization block** is an intraventricular form of block, occurring at a level still more distal than branch bundle block, and ascribed to disease of the Purkinje cells. These cells line most of the inner surface of the ventricles, and have the property of conducting the contractile impulse 10 times as rapidly as the muscle tissue itself. Disease involving this network, frequently of a sclerotic type, results in lack of synchrony in the contraction of the different parts of the ventricular walls. As described by Oppenheimer and Rothschild, the electrocardiographic features of this form of block include: (1) Broadening of the *Q-R-S* group beyond the normal limit of  $\frac{1}{10}$  second. (2) Notching, sometimes multiple, of the *R* wave. (3) Usually, a low amplitude of the *R* wave in all 3 leads, assisting in the differentiation from branch bundle block. The finding of this form of block is regarded as prognostically unfavorable, such cases having shown an unusually high mortality.

**Sino-auricular block**, an uncommon form of arrhythmia, sometimes associated with ordinary heart block, is characterized by normalcy of both the auricular and ventricular complexes, with an occasional sudden lengthening of the diastolic record so that it appears as if one entire beat of the heart had dropped out, or with a sudden fall of the heart rate almost to  $\frac{1}{2}$  the pre-existing rate. Where a single beat drops out, the interval between the preceding and following beats does not quite equal the length of 2 normal beats. This arrhythmia is unrelated to the respiration, may be induced by digitalis through vagal stimulation, occurs mainly in children and young adults, and is apparently not of pathologic significance. Some have considered it to be, not a true block, but the result merely of a temporary abeyance of activity at the sino-auricular node.

[In Figs. 9 and 10, Plate II, Cowan (Glasgow Med. Jour., Jan., 1926) brings out the temporary character of certain electrocardiographic findings in a minority of the cases. Fig. 9 is from a boy of 14 years who had had "hemic" murmurs and a juvenile pulse irregularity, but at that time had a normal electrocardiogram. Soon after he had pneumonia and empyema, and a year

later, mumps, during convalescence from which his heart became dilated from over-exertion. The record shown in Fig. 9A was then obtained, suggesting defective conduction along the right branch of the bundle. *RI* is normal, but is succeeded by a broad *S* with a thickened ascending limb. *T* is positive. The *Q-R-S* period measures  $1\frac{1}{100}$  to  $1\frac{3}{100}$  second. In Lead *III* a small *S* is followed by a positive deflection of short duration; *T* is absent. Three months later the boy's cardiac dilatation had definitely lessened and the electrocardiogram returned to the normal form shown in Fig. 9B. At 19 years he was in good health, athletic, and the electrocardiogram remained normal.

Fig. 10 illustrates an instance of change in ventricular preponderance. A young man of 18, after a feverish cold, developed pains in the chest and a slightly irregular pulse, with a systolic murmur at the base. In 6 weeks these manifestations all disappeared. The electrocardiogram (Fig. 10A) pointed to right-sided preponderance (deep *S* in Lead *I* and tall *R* in Lead *III*). Six months later he was in good health, with the preponderance left-sided. The change of preponderance suggests that the left heart had been strained by excessive activity during the infectious catarrh, with recovery during the succeeding 6 months].

Vertigo, convulsions, or unconsciousness, of short or long duration, epileptiform seizures, and slow pulse, coming on without warning or with an ill-defined aura, have been erected into a group under the name of the *Adams-Stokes syndrome*. The attacks are attended with an anemia of the nervous system, brought about by the slow action or temporary arrest of ventricular systole. An arrest lasting 12 seconds or more results in a severe attack. Most cases of heart block do not develop these Adams-Stokes attacks, which are dependent upon an acute slowing of the heart rate in excess of the preëxisting partial or complete block.

In heart block, when it appears

that the infrequent pulse is due to excessive vagus influence, **sulphate or nitrate of atropine** in  $\frac{1}{60}$ -grain (0.001 Gm.) doses is usually effective, but has no curative value. In the Adams-Stokes syndrome, Dock has given **strychnine nitrate** in  $\frac{1}{20}$ -grain (0.003 Gm.) doses with successful results. If there is high pressure, **nitroglycerin** in doses of  $\frac{1}{200}$  to  $\frac{1}{400}$  grain (0.0003 to 0.0006 Gm.) has proved useful. **Digitalis** in Adams-Stokes disease may, according to my experience, be used with advantage. **Amyl nitrite** and **oxygen** may be used in the attacks. **Morphine** should be used cautiously. If an acute heart block is caused by digitalis, the drug should, of course, be suspended at once. If syphilis exists, **antisyphilitic remedies** should be used according to the established rules.

**Foci of infection** should be sought and removed. Prolonged rest in bed will sometimes yield definite improvement.

**Pulsus Alternans.**—The alternating heart shows an alternation of large and small beats. The alternation is continuous—which distinguishes this type of disturbance from extrasystolic arrhythmias. The intervals between beats are regular, and the rate is normal or but slightly accelerated. At times, however, the disturbance may be combined with paroxysmal tachycardia or auricular flutter. In tracings it is sometimes observed to set in after a premature contraction. It is less uncommon than was formerly thought, occurring not infrequently in cardiac decompensation or pronounced high blood-pressure, and is occasionally induced by digitalis. In general, it is of unfavorable prognostic significance, al-

though it may disappear under **rest** and **digitalis**.

Alternation of the heart can sometimes be detected by palpation at the wrist, but may be confounded with extrasystolic arrhythmia where prematurity of the beat in the latter disturbance is slight. The sphygmomanometer will detect it readily, showing for a time  $\frac{1}{2}$  the usual rate of pulsation as the pressure in the cuff is gradually lowered from complete obliteration; auscultation of the vessel is also serviceable. Alternation is likewise well demonstrated in a sphygmogram from the radial pulse. In the electrocardiogram the alternation is frequently less distinct than in the sphygmogram.

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## HEART, FUNCTIONAL TESTS OF, AND OTHER DIAGNOSTIC PROCEDURES.—

**FUNCTIONAL TESTS.**—The functional efficiency tests which might prove of use in general practice have been reviewed by Satterthwaite thus: The *trigeminal irritation test*, by the inhalation of strong smelling salts which slow the normal heart but accelerate the neurotic heart. The *oculocardiac test*, elicited by pressure on one or both eyeballs. By this method the normal rate is slowed 4 to 10 beats per minute. Any increased degree of retardation suggests trouble with the cardio-neural mechanism. The *atropine test*, in which from  $\frac{1}{25}$  to  $\frac{1}{60}$  grain increases the normal beat from 30 to 40 per minute, while in hearts with myocardial degeneration the increase may be only 20 beats or even less.

Other tests depend upon the reaction of the heart muscle to either active or passive exertion. Of these, the *Selig test* has been very frequently used. The pulse and systolic blood pressure are taken before and after the subject climbs a flight of 20 steps. Normally there is an increase of 20 beats per minute and a rise of blood pressure of 8 mm. Hg. If the myocardium is insufficient, the pulse rate increases 30 or more beats, while the blood pressure rises more slowly, or falls. The length of time taken for the recovery to the normal systolic pressure may be re-

garded as the index of cardiac efficiency. The *hopping test* consists in having the patient hop 20 paces on one foot. It is a modification of the Selig test, but not as useful as some others, inasmuch as the work performed cannot be computed accurately.

*Graüpfner's test* is a better method, as it consists in having the patient perform a definite amount of work with the ergometer, and depends on a comparison of the behaviors of pulse rate and arterial pressure. In the normal heart under exercise the systolic pressure rises after the acceleration of the rate, and after rest, is maintained longer than in the inefficient heart, where the pressure rise is both delayed and diminished. The *stair climbing test* is another practical and useful method, in which the amount of work is estimated in foot-pounds, the latter being computed by multiplying the number of pounds the individual weighs by the number of feet ascended. Thus an energy-index is provided.

The *Herz test* consists of simple flexion and extension of the arms; in persons with weak hearts the rate increases 5 to 20 beats a minute.

*Katzenstein's test* consists in compressing both femoral arteries. If the arterial pressure rises some 15 mm. Hg and the pulse rate does not rise, or even slows a little, the heart is held to be vigorous. If the pressure falls and the pulse rises in rate the heart is insufficient.

In *Schapiro's test* the pulse is taken first in the recumbent and then in the sitting position. In health there is an increase of frequency when the individual has assumed the sitting posture (after lying down), of from 3 to 10 beats per minute. In the weak heart there is an absence of change or a diminution of the frequency in changing from the recumbent to the sitting position. This method is applicable for ordinary civilian practice.

According to Secher, the following tests are serviceable and simple enough for office or house practice:

In *Schrumpff's test*, if the heart is normal, the pulse should return to its former beat in 4 minutes after slight exercise, such as bending the knees 10 times.

*Katzenstein's test* is the difference in



pulse and blood pressure before and 2 minutes after digital compression of the femoral artery for 2 or 2½ minutes. A rise in blood pressure and slower pulse-rate indicates normal condition. An abnormally high rise in blood pressure is found in arteriosclerosis and cardiac hypertrophy. No rise in blood pressure indicates weakness of the heart; if the pulse is not modified, the weakness is slight, but if the pulse grows faster the heart must be regarded as decidedly insufficient. A drop in blood pressure with accelerated pulse indicates severe insufficiency; it is proportional to the degree of each. This test can be applied to the reclining patient. In some cases it excluded organic heart disease, and the course later confirmed its findings. The *Rehfishch* test is carried out by auscultation before and after bending the knees 10 times; *Bock's differential stethoscope* eliminates the personal equation in estimating the findings.

Response of the heart rate to *atropine* or to *amyl nitrite* shows that the heart is under vagus tone, but not necessarily, according to Fredericq, that any bradycardia previously present was of vagus origin. In partial heart-block the rate responds to these drugs, but not in complete block. Mougeot affirms that subcutaneous injection of 1 or 2 mgm. ( $\frac{1}{65}$  to  $\frac{1}{32}$  grain) of *physostigmine* salicylate always slows the heart unless the myocardium and innervation are extremely abnormal; a negative response shows that the rhythm is no longer obeying the supracardiac nervous mechanism.

According to Brittingham and White (Jour. Amer. Med. Assoc., Dec. 2, 1922), the *exercise tests* based on changes in systolic pressure seem more reliable than those based on changes in pulse rate. The test they used is as follows: The patient, if an adult, swings 2 20-pound dumb-bells from the floor to arm's length overhead 10, 15, and 20 times, allowing from 2 to 3 seconds for each complete swing. Systolic blood-pressure is then taken as soon as possible and followed at 10 to 15-second intervals until it is definitely dropping, then at 30-second intervals until it reaches within 6 mm. of the preëxercise level. In normal persons thus working nearly up to their limit of capacity, in the "effort syndrome," and in organic heart cases, the pressure

curve shows a "delayed rise" or "delayed summit" and "prolonged fall." In the authors' heart and other cases, the test gave rather irregular results, the delayed rise seeming to depend much more on general muscular condition than on what appeared their true "cardiac reserve." The general reaction of an individual to the habitual activities of life, such as the ascent of stairs, generally affords more valuable information than any of the functional tests.

Magnus-Alsleben (Klin. Woch., Jan. 1, 1924) asserts that the simplest and most helpful method is based on the pulse rate and respiratory frequency, and the promptness of their return to normal after a measured amount of muscular work, adapted to the age, constitution and physical training of the patient. After a healthy young man, with a pulse rate of 70 to 80 and respirations of 18 to 20, bends his knees about 40 times the pulse rate will be about 115 and the respirations about 30. The pulse and respiration rates will return to normal within a minute, at the most.

A modified *Goodall progressive exercise* test was carried out by G. H. Robertson (Med. Jour. and Rec., Aug. 19, 1925) in a number of normal subjects and patients. The subject steps up and down from an ordinary chair 30 times in 60 seconds, thus lifting his body weight through 45 feet in that time. (This unit exercise is a little more than double the exercise—20 feet in 30 seconds—suggested by Goodall). He then lies down on a bed or couch, and readings of the pulse rate and the systolic and diastolic pressures are taken. This usually occupies 30 seconds, whereupon the exercise is immediately repeated. The process is continued until the readings show a falling systolic and pulse pressure or the patient shows signs of considerable distress. The body weight and height of lift being known, the work done can be expressed in foot-pounds.

Both the pulse rate and systolic pressure rise on exercise, but the systolic pressure reaches a maximum earlier in exercise than does the pulse rate. The systolic pressure, after rising, tends to fall to a certain level which is maintained for the rest of the exercise. As the subject "gets into his stride," the pulse rate also reaches and maintains a certain level. Upon

resting, both the systolic pressure and pulse rate fall rapidly. A fall of the pressure markedly below its original level indicates severity of the exercise and when met with after mild exercise may, as stated by Otis, be taken as a sign of diminished cardiac reserve. Robertson is convinced from his series of tests that in normal subjects there is a fall in diastolic pressure during exercise and a rise at the conclusion of exercise. Cases of "effort syndrome" without objective signs of cardiac disease show on exhaustion a falling pulse rate while maintaining blood-pressure levels. Exhaustion of the sympathetic nervous system is suggested as a cause of this. Patients with cardiac enlargement, arteriosclerosis, or other condition of unhealthy myocardium show on exhaustion a fall in systolic and pulse pressure with a pulse rate persistently rapid or increasing. Exhaustion of the myocardium will explain these occurrences.

**VITAL CAPACITY.**—Vital capacity is determined by having the subject inhale as deeply as possible and then exhale fully into a spirometer. This capacity is reduced in cardiac failure of the congestive type, and, if failure is well-marked, is more than 10 per cent. below the calculated normal in 100 per cent. of cases. Peabody and Wentworth found that patients with a vital capacity of 90 per cent. or more of the normal were able to carry on their work with very little dyspnea. Those with 70 to 90 per cent. became dyspneic on unusual exertion. Those with 40 to 70 per cent. became dyspneic on moderate or slight exertion, and those with less than 40 per cent. were decompensated patients usually confined to bed.

The normal vital capacity is calculated for each individual from the total surface area of the body. The latter may be determined by the linear formula of D. and E. F. DuBois (*Arch. of Int. Med.*, June, 1916). As noted by J. H. Pratt (*Amer. Jour. Med. Sci.*, Dec., 1922), who believes the vital capacity a good index of cardiac reserve power, West's standard of vital capacity for men is 2.5 liters per sq. meter of body surface, and for women, 2 liters. The mean in 100 persons with normal hearts was 3500 to 4000 c.c.; in 100 with abnormal hearts, 1500 to 2000 c.c. In insufficiency of the congestive type, the vital

capacity follows closely changes in the clinical condition.

T. Ziskin (*Arch. of Int. Med.*, Feb., 1925), in observations on 207 cardiac patients, found that in 70 cases of organic disease which were able to carry on with greatly diminished physical activity the average vital capacity was between 81 and 85 per cent. of normal. In 20 cases with "possible heart disease" (doubtful murmurs mainly functional) the average was 96 to 100 per cent. There was no definite relationship between the vital capacity and the type of heart lesion, although the vital capacity tended to be lower in mitral stenosis than other conditions. Vital capacity in heart disease undoubtedly bears a relationship to the symptom dyspnea, but that it parallels the reduction in cardiac efficiency is not shown by the results obtained. The vasomotor system is a great factor, as in all tests for cardiac efficiency, and among other possible complicating factors are chest rigidity, weakness of the intercostal muscles, pleural effusion, emphysema, cardiac enlargement, enlarged liver, abdominal tumors and ascites.

#### ROENTGEN RAY EXAMINATIONS.

—The X-ray, suitably applied, has proven far superior for exact determinations of the size of the heart in its various dimensions than the older method of percussion. To avoid, however, the inaccuracies resulting in the size of the X-ray image of the heart owing to the divergent character of the rays passing from the X-ray tube to the cardiac borders, certain special modes of application are required.

In **orthodiagraphy** (orthofluoroscopy) a device is used whereby only rays perpendicular to the screen are employed, these rays being passed tangentially along the cardio-aortic outline by a gradual displacement of the X-ray tube. By joining with a continuous line a number of points thus determined on the screen, a rather exact outline of the heart and great vessels is obtained.

In **teleroentgenography** approximately parallel rays are secured by having the X-ray tube at a distance of 2 or 3 meters from the subject, thereby reducing the error arising from conical projection of the rays to a negligible amount. A brief single exposure of the heart, preferably during

diastole, on a sensitized plate yields the desired outline of the organ. With the X-ray tube at a distance of only 28 inches, the same result can be obtained in the case of the greatest transverse diameter of the heart by deducting 1 centimeter from the figure actually obtained.

According to Claytor and Merrill, the average normal transverse diameter in men weighing 109 to 117 pounds is 11 cm., and in those weighing 168 to 181 pounds, 13 cm., with regular gradations for the intermediate weights. According to Bardeen, this diameter is 5 cm. at birth, 7 cm. at 1 year, and 11 cm. at 14 years; in adults weighing 200 pounds, it is 15 cm.

Where the heart shadow is enlarged in all diameters and seems shapeless and flaccid in that its shadow rests upon a broad base and is narrow above, the organ is dilated. If, on the other hand, the enlarged heart shows well defined arcs corresponding to its several chambers, and has a shape characteristic of an existing valve lesion, it may be considered to be hypertrophied rather than dilated.

Combined fluoroscopic, radiographic and orthodiagraphic examination has been advocated by L. F. Bishop (N. Y. State Jour. of Med., May, 1923). Useful observations include extensive systolic expansion of the lower right border (right auricle) in some cases of tricuspid regurgitation, and of the upper left border (aorta) in aortic insufficiency. Pulsations of the left auricle, if visible, as in mitral lesions, are presystolic. Strong pulsation of the pulmonary artery on the left side occurs in persistent ductus arteriosus and more often in severe stasis due to mitral lesions. Changes in position of the heart are seen. Left ventricular enlargement takes place to the left; right ventricular enlargement, to the right, but also upward and to the left. In typical aortic insufficiency the heart shadow is enormously increased toward the left (shoe-shaped heart); the aortic shadow is increased in width, and the apex never merges with the shadow of the diaphragm. Aortic stenosis produces similar but less marked changes. In mitral stenosis the heart shadow is relatively small, more nearly a vertical oval, with the left border presenting a step-like appearance. In mitral insufficiency enlargement is uniform in all directions.

Vaquez and E. Bordet (Paris méd., July 5, 1924) point out that certain patients may have for years physical signs apparently indicating a good adaptation, while on the contrary, repeated fluoroscopies show that the lesions are slowly progressing, and that continuous treatment is necessary in spite of appearances. Again, fluoroscopy sometimes reveals such sudden changes in the volume of the heart or aorta that grave complications may be foreseen and the need of emergency treatment recognized. In moderate hypertension, there may be a rather sudden rise of blood-pressure, and it becomes necessary to know how the heart is bearing the strain; a marked increase in size of the left ventricle revealed by the X-ray indicates dilatation and the need of suitable treatment. S.

## HEART, PALPITATION OF THE.

—Although the term "palpitation" means the rhythmical normal action of the heart, it is commonly applied to undue frequency of the beats, sufficiently marked to cause discomfort, accompanied by more or less irregularity in the rhythm and, in marked cases, precordial distress, dyspnea, and anxiety.

**SYMPTOMS.**—The slight attacks of palpitation with which most of us are familiar are accompanied by more or less oppression and precordial distress. During violent paroxysms these manifestations are increased in proportion, and the heart beats may become tumultuous; the beat against the chest is violent; the patient can speak only with the greatest difficulty; his face is pale and covered with cold sweat, and he may suddenly lapse into unconsciousness. While the arteries throb violently, the throbbing may not correspond with the cardiac pulsations. The radial pulse may seem quite normal, yet violent cardiac action exist. Again, the heart may simply beat with increased force but no rise in rate.

In so-called "stage fright," violent palpitations may precede entrance upon the stage; as soon as this is accomplished, the heart's action becomes regular in every way. What is foolishly branded "cowardice" in some young soldiers is often but the cardiac manifestation of excitement, which soon disappears after an action in-

volving physical effort has begun. In some cases, especially hysterical women, the least emotion may bring on an attack.

**DIAGNOSIS.**—The physical signs are negative in mild cases, as a rule, unless some form of valvular disease be present. The ring of the sounds is merely accentuated. In cases of anemia or neurasthenia a murmur is sometimes heard.

In severe cases the cardiac impulse is forcible and venous throbbing is noticeable. The pulse is full, hard, and rapid, attaining 170 or more in some subjects. In anemic individuals, who are prone to palpitation, anemic murmurs may be heard on auscultation besides the exaggerated cardiac sounds.

Valvular disorders often give rise to palpitations; the cause is then readily established by auscultation.

**ETIOLOGY.**—Palpitation is much more frequently met with among females than males, especially around puberty and the menopause. Uterine and ovarian affections and hysteria are commonly observed in cases subject to cardiac neuroses of all kinds. It is often a complication of menopause.

In men it is liable to occur when the anxiety of business and responsibilities of life accumulate. Emotions, excitement, and fear are well-known causes. The abuse of certain beverages, particularly tea and coffee, is often a factor in the history of some cases. The inordinate use of tobacco may be included in this class. Various diseases—especially digestive disturbances, anemia, and chronic valvular disorders—are active or causative disorders in but a small proportion of cases. It may follow acute fevers and continued overexertion, witnessed in armies—the “irritable heart” referred to above. Acute infectious diseases may cause palpitation owing to the morbid effects of toxins upon the nervous mechanism of the heart. Hyperthyroidism may also be a cause.

As for the arrhythmias, palpitation is common in extrasystolic arrhythmia, the patient becoming aware of the large beat which follows the premature contraction; in these cases the palpitation is felt more especially upon rest after exercising, and exercise may give relief from the palpitation. The symptom is met with occasion-

ally also in auricular fibrillation, especially if the heart rate is high. In paroxysmal tachycardia the patient is likely to be conscious of the onset and termination of the paroxysm. In general, palpitation is in more instances associated with forcible, rapid, regular heart action than it is with the arrhythmias.

**TREATMENT.**—To arrest a paroxysm of palpitation **rest** in the recumbent position in a well-ventilated, darkened room and loosening of the clothing should precede all other measures. Sipping **cold water** or eating **cracked ice** and the application of a **cold compress over the heart** often suffice to arrest the paroxysm. **Digital pressure upon the vagus** below the angle of the jaw or **over the ovaries** is helpful. A **spray** of a 5 per cent. **solution of cocaine** may be used in the **nostrils** and may prove effective reflexly. A warm, **stimulating drink**, **aromatic spirit of ammonia**, and in hysterical subjects the **bromides** and **valerian**, are often effective. **Monobromated camphor**, **oxygen inhalations**, and, as a last resort, **morphine hypodermically**, have been highly recommended. Sometimes palpitations are due to an overloaded stomach; an **emetic** is then indicated and proves rapidly effective.

In paroxysmal tachycardia the following measures are recommended by Vaguez to overcome the paroxysm:—

1. **Lying on his back**, the patient should execute very slowly **inspiratory movements**, keeping the chest well filled with air during the intervals.
2. He should drink **water** or some other fluid, executing **energetic swallowing movements**.
3. Every ten minutes he should take a cachet containing 0.15 Gm. ( $2\frac{1}{2}$  grains) of **pituitary gland substance**.
4. Mild compression of the right pneumogastric nerve in the neck.
5. **Tickling of the pharynx with a feather**.
6. If the condition is not relieved in twenty-four hours, the patient should be given 2 dessertspoonfuls of syrup of **ipecac** at a ten-minute interval.
7. If the tachycardia should happen to persist longer than three or four days, and signs of marked cardiac insufficiency appear, an intramuscular

injection of 0.5 mg. ( $\frac{1}{28}$  grain) of amorphous **strophanthin** should be given; next day, 1 mg. ( $\frac{1}{14}$  grain) and the third day, if necessary, an intravenous injection of 1 mg. C. Esmein (Jour. méd. français, Feb., 1913).

To prevent recurrence of the attacks the cause should be sought and eliminated. In many cases the condition is due to excessive coffee or tea drinking or to inordinate smoking, and in some to masturbation or excessive venery. S.

### HEART, IRRITABLE.

This condition, first described by J. M. DaCosta, who had studied it during the Civil War, was particularly prevalent during the World War, representing, according to Meakins, Lewis and others, 50 to 55 per cent. of all cardiac diseases encountered by them among soldiers.

The condition has also been termed the **effort syndrome**, **neurocirculatory asthenia**, **disordered action of the heart** ("D. A. H."), and **soldier's heart**. Since the World War it has been recognized that the disorder occurs in civilians, including adults of both sexes and children.

**Symptoms.**—Pallor, paroxysmal dyspnea, fatigue, and even exhaustion, on moderate exertion, sometimes accompanied by pain about the heart, tachycardia, the pulse-rate reaching often 120, occasionally attended with arrhythmia, both increased by exertion, and more or less insomnia, are the more prominent symptoms; slight cyanosis, especially of the lips, is occasionally observed, also vertigo, fainting. There may be a coarse tremor of the hands and free sweating in the axillæ. Lian states that in light cases it appears only on marching, and passes off with rest, but that in others it persists even in recumbency, with a pulse-rate often of 100.

The physical signs are variable. Systolic murmurs and thrills are frequent; the heart is usually dilated to an appreciable extent. Many authors have held that the blood-pressures, both systolic and diastolic, are low, but according to Martinet and others, this is only exceptionally the case, both being high as a rule. The systolic pressure is especially likely to be elevated after the increase of tachycardia induced by exercise. The apex beat may be found diffuse and forcible, a confusing impression of hypertrophy of the heart resulting.

According to Porter, precordial pain was one of the most consistent symptoms observed in the cases among soldiers. Its distribution was usually around the left nipple, yet in rare cases it extended down the left arm. It was usually sharp, but not in a single one of his cases was it associated with substernal constriction or pain—a point of value in the distinction from true angina.

**Irritable Heart in Recruits.**—Notwithstanding Mackenzie's conclusion that an *organic valvular lesion* should not be regarded as a reason for rejection, provided the muscular action of the heart be satisfactory, the British Army Medical Service found it advisable during the World War absolutely to reject a recruit with organic valvular disease. This applied also to *endocardial murmurs*, an *extrasystolic heart*, and *auricular fibrillation*. A man could be accepted, however, when a functional bruit at the apex disappeared on assuming the erect position and when he showed a rhythmical variation of pulsation associated with respiration, perhaps with an occasional reduplication of the second sound, the symptoms being purely physiological.

The physical signs sufficed, according to Meakins and Lewis (Brit. Med. Jour., Sept. 23, 1916), to recognize about 40 per cent. of the men referred to them for cardiac symptoms as unfit. Most of the

others showed various symptoms, dyspnea, palpitation, vertigo, or fainting. By suitable exercises an additional 5 per cent. of the original group were found unfit for service, but in all about 50 to 55 per cent. of soldiers suffering from cardiac symptoms were found fit for some form of military duty by the tests. All of the men in this group were suffering from "irritable heart."

The writer emphasizes the satisfactory showing made in active service by 12 men suffering from chronic valvular or myocardial disease, when prophylaxis through the use of the intermittent small doses of digitalis, to prevent sudden dilatation under active exertion, was insured. In most instances, 0.1 mg. ( $\frac{1}{1000}$  grain) of crystalline **digitalin** (French) was given on 2 or 3 consecutive days in each week. C. Fiessinger (Bull. de l'Acad. de Méd., Dec. 29, 1914).

**Etiology.**—The precise etiology of the disorder is still obscure. According to some, it is to be regarded as a group of symptoms and signs that may develop under various conditions. Abrahamson, believing that the heart cannot be damaged by overstrain, even that incident upon warfare, incriminates toxins, the ductless glands, and the vascular nervous mechanism rather than the heart itself. Kramer blames the excessive use of tobacco, the palpitations and arrhythmia having ceased on stopping its use.

There is a fundamental factor in all cases of neurocirculatory asthenia, *viz.*, nervous and emotional instability which brings about, or is associated with, hyperexcitability or lack of inhibition of the sympathetic nervous system. Only 4 per cent. of the cases studied by Lewis showed probable enlargement of the thyroid. Among civilians, according to the writer's observations, the syndrome is far more common in men than women (18 to 1). He never observed it after the age of 35, and the youngest patient was 19. It occurred almost exclusively in

students, clerks, physicians, engineers and lawyers; only 2 patients led active outdoor lives. Worry, overwork or overstudy were factors in the majority of cases. In  $12\frac{1}{2}$  per cent., local infections probably played an important rôle. The symptoms were the same as in the cases previously observed in soldiers, with the exception that violent palpitation, severe precordial pain and a high rate of tachycardia were not witnessed. Some cases had gastrointestinal symptoms, including gastric discomfort and distention and attacks of sudden diarrhea. G. M. Piersol (Med. Jour. and Rec., Nov. 4, 1925).

Lewis has divided the cases into 6 classes: (1) Persons with inherent nervous instability and constitutional weakness (the largest group); (2) cases induced by fatigue from hard work, lack of rest, insufficient food and exposure; (3) cases following an acute infection, as pneumonia, influenza, etc.; (4) cases with some unrecognized focus of chronic infection or incipient phthisis; (5) cases due to (military) gas poisoning; (6) cases of incipient, but unrecognizable heart disease.

Sajous (I'a. State Med. Jour., Jan., 1919) states that true soldier's irritable heart is mainly due to excessive activity of the adrenals, induced by fear, excitement, etc., leading to exhaustion of these organs. The heart and blood-vessels being deprived of the organic substances which sustain their tone, the specific symptoms of the disorder are awakened. In cases predisposed to thyroid disorders, however, it may be due to hyperthyroidism.

**Treatment.**—On the whole, **rest** and **digitalis**, and very gradual resumption of physical exercise are indicated. The following mixture was found extremely beneficial by Mackenzie in many cases of "soldiers' heart":

℞ *Ammon. brom.* ..... 24 Gm. (6 dr.).  
*Liq. extract ergot* .. 24 c.c. (6 dr.).  
*Tinct. digitalis* ..... 8 c.c. (2 dr.).  
*Spt. ammon. aromat.* 16 c.c. (½ oz.).  
*Aque* ..... ad 180 c.c. (6 oz.).

M. Sig.: (1) One-half ounce in water, after meals every 4 hours for 2 days; (2) one-half ounce in water, after meals 3 times a day for a week after; (3) gradually reduce to twice daily, and then once daily according to reaction.

After the abnormal fatigue ceases, **massage** is indicated, and also **cool baths** instead of warm baths. Graded exercise should then be started.

In neurocirculatory asthenia the patient's **mode of life** should be gone over and **readjusted** so that he may undertake the work for which he is best adapted, physically and mentally. Those obsessed with the idea of serious organic heart disease gain much benefit from **instruction** and **reassurance**. **Graduated exercises**, very mild at first, are most important. Other useful agents are general **massage**, **tepid** or **cool baths**, **salt rubs**, **fresh air** and **sunshine**, **removal of foci of infection**, and a well-balanced and high caloric diet. Digitalis is useless. **Bromides**, **phenobarbital**, etc., are useful for undue apprehension or marked insomnia. **Adrenal preparations** have been advocated. G. M. Piersol (Med. Jour. and Rec., Nov. 4, 1925).

## HEART, UNCOMMON DISORDERS OF THE.

### TUMORS OF THE HEART.

Growths of the heart are infrequently observed. They include lipoma, myoma, angioma, cyst, gumma, sarcoma, and carcinoma, the last two being usually secondary.

**SYMPTOMS.**—Until recently these cases were seldom recognized during life.

When a heart tumor involves the left auricle, a not infrequent site, the symptoms are, as a rule, rather clearly

defined. The dyspnea is out of proportion with the apparent degree of cardiac involvement and shows paroxysmal exacerbations due to momentary blocking of one of the orifices. Brief syncopal attacks, with or without loss of consciousness, are to be similarly explained. Rapid loss of weight and strength is of diagnostic value. The area of cardiac dullness may be considerably enlarged, and a systolic murmur or reduplication of the second sound be noted, according to the situation of the growth. Irregularity of rhythm is also frequent. Especially distinctive, however, is the marked variability and disconcerting vagueness of the signs present. Multiple embolism, lung infarction, and sudden, unexpected exitus are also characteristic. An esophageal pulse tracing, when compared with the jugular tracing, shows that the auricles are not contracting equally. Bard has found that the esophageal tracing shows a much less pronounced postsystolic rise than normal, the curve at this point attaining a level much lower than that of the presystolic and systolic elevations, whereas normally the opposite is the case. This is due to rigidity of the posterior wall of the left auricle owing to its infiltration by the tumor. Another abnormality is the marked diminution in the presystolic rise, which contrasts with the normal rise seen in the jugular tracing and referable, therefore, to the right auricle.

The history of the case may afford considerable aid. Thus, as shown by Huchard and Fiessinger, the occurrence in old syphilitics of a gradually progressive dyspnea, edema, and cyanosis, with often a small, rapid, high tension, and perhaps arrhythmic

pulse, is very suggestive of cardiac gumma, which appropriate measures soon overcome, where cardiac therapy on the usual lines will prove absolutely sterile in results.

**TREATMENT.**—It is safe in all such cases to try mercurials, preferably the **biniodide of mercury**, in  $\frac{1}{16}$ -grain (0.004 Gm.) doses thrice daily, or **sodium iodide** in increasing doses, especially when the usual measures addressed to cardiac disorders fail to procure benefit. If cachexia suggests the possible presence of sarcoma, **Coley's fluid** might be tried. Several cases are on record in which cardiac conditions developing in luetic patients have been either cured or greatly improved by specific treatment associated with very little cardiac therapy.

### PARASITES OF THE HEART.

The parasites which may occur, though rarely, in the heart muscle are: echinococci and cysticeri, *Trichina spiralis*, and *Streptothrix actinomyces*.

**SYMPTOMS.**—Although the morbid process caused by echinococci, the parasite most commonly found in the cardiac muscle, may be advanced, the patient may show no impairment of health until he suddenly falls into coma, soon followed by death.

Again, the lethal course may be gradual, the patient, though previously well, experiencing severe pain in the epigastric region, dyspnea, cyanosis, feeble and irregular pulse, and finally syncope.

The known presence of echinococci in other parts of the body should suggest possible involvement of the heart when cardiac phenomena appear. What diagnostic signs we have are limited to those observed in tumor of

the heart, a subject considered under the preceding heading.

**TREATMENT.**—Obviously the surgical measures adopted in echinococcus disease elsewhere can hardly be carried out in the heart, even though a correct diagnosis be made, which is very rare. The presence of parasites elsewhere in the body being accompanied by cardiac phenomena, what internal treatment may prove of service for the parasite which happens to be present in a given case should be employed. These various agents are enumerated in the article on PARASITES.

### ANEURISM OF THE HEART.

A cardiac aneurism may involve the myocardium, the valves, or the coronaries without apparent preference for either of these arteries and very near its origin from the aorta.

Case of parietal cardiac aneurism recognized roentgenoscopically in a woman of 27 years. It was located high up in the left ventricle. Syphilis was absent. There was tachycardia and dyspnea on exertion, but no arrhythmia. The first sound was followed by a soft murmur. There was severe anginoid pain. Such pain, when localized at the apex and developed by pressure, points to cardiac aneurism when the heart is weak and unstable. Most cases of aneurism of the cardiac wall occur in men over 40 years of age. Berginié and Moulinier (Arch. d'électr. méd., Mar., 1923).

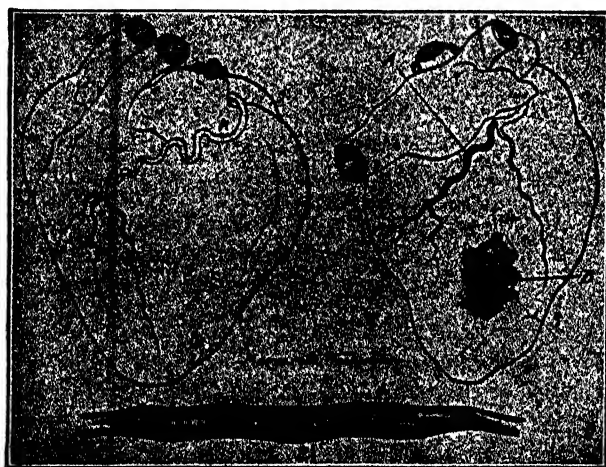
**SYMPTOMS.**—According to Kasem-Beck, as previously shown by Skoda, a marked heaving of the intercostal spaces with the heart beat in conjunction with a small pulse curve in the radial artery is a certain sign of aneurism of the left ventricle. Coronary aneurism does not seem to give rise to any characteristic symp-



tom, though dyspnea, cough, and fleeting pains about the heart may be complained of. Dullness on percussion, a pulsating prominence, and perhaps a blowing murmur may be discerned. An X-ray examination is very helpful as an aid to diagnosis. Valvular aneurisms which sometimes occur in the course of ulcerative endocarditis cannot be recognized during life.

structures. If adhesive pericarditis exists, it is justifiable to recommend **cardiolysis** to lessen the strain on the heart-muscle which results from the constant systolic pull of the adhesions. Ellsworth Smith (South. Med. Jour., Dec., 1922).

The course of these cases is toward death, which may result from gradual exhaustion of the heart or rupture. Coronary aneurisms usually terminate by rupture into the pericardium



**Aneurism of the heart with thrombosis of the left coronary artery. (Daland.)** 1. Extreme tortuosity of the right coronary artery. 2. The right coronary artery laid open so as to make visible the masses of fibroid material in the wall, which projected into the lumen of the vessel to such an extent as to cause almost complete occlusion. When the artery was emptied of blood a very fine probe could be passed through it by lifting the thinner portion of the wall away from these masses. 3. (A) A moderately tortuous left coronary artery, the shaded portion of which represents the regions filled by a thrombus; B shows the location of an area of chronic pericarditis, immediately overlying the aneurism of the heart.

In the diagnosis of cardiac aneurism, attention should be paid to a possible history of a more or less rapid coronary occlusion by thrombosis; the finding of 2 separate points of impulse in the cardiac area, and the determination of an abnormal cardiac outline by physical and X-ray examination. It is important to determine a possible complicating chronic adhesive pericarditis through fixation of heart dullness, retraction in the apical region and Broadbent's sign, and X-ray evidence of pericardial adhesions to surrounding

and death. Valvular aneurisms likewise tend to rupture, leaving the affected valve incompetent.

**TREATMENT.**—So far therapeutic resources have proved unavailing, though some benefit has resulted from the use of **gelatin**.

Whatever methods for the treatment of aneurisms in other parts can here be utilized should, however, be tried. (See **ANEURISM, TREATMENT**, Vol. I.)

### MOVABLE, MOBILE, OR WANDERING HEART.

Although too much importance should not be ascribed to variations of position of the heart as compared with the average limits of mobility, there are cases in which this is excessive and in which appropriate measures will afford relief. In a case reported by Rumpf, for instance, the apex beat shifted 13 cm. when the position of the body was changed sidewise, while the average normal movement of a heart is  $3\frac{1}{2}$  cm.

**SYMPTOMS.**—In some cases there are no symptoms, but in the large majority there are attacks of palpitation, a sense of weakness with a tendency to vertigo, especially upon running or exertion, and also inability to lie upon the side, particularly the left, relief occurring promptly when the patient lies on his back or assumes the upright or semi-recumbent position. Some cases show incapacity for work, marked uneasiness and anxiety, asthma, and tachycardia.

A diagnosis of movable heart is justified, according to Leusser, if the area of cardiac dullness, which is normal when the patient stands up or lies on the back, is replaced by an area of resonance between the sternum and the left border of the heart when the patient lies on the left side and when, at the same time, there is displacement of the systolic shock to the left and a return to its original position when the patient rolls on the back.

These cases must, of course, be differentiated from teratological abnormalities, such as dextrocardia, etc.

**ETIOLOGY.**—An examination of 1000 persons with regard to mobility

of the heart led Pick to conclude that in a very great majority of normal subjects there was no perceptible difference in the area of dullness on percussion, nor in the position of the apex, on change of position of the subject. In about 6 per cent. of the cases the heart settled somewhat toward the left when the subject lay on his left side, say  $1\frac{1}{2}$  to 2 cm. (0.6 to 0.8 inch). Abnormal mobility was found in some healthy and powerful persons as an apparent congenital anomaly, and, again, as an accompaniment of organic disease of the heart and of other organs, without, however, any apparent etiological relation to the latter.

Abnormal mobility may develop as a result of emaciation, on account of the disappearance of pericardial and abdominal fat. Disorders which increase the weight of the heart, such as hypertrophy, tumor, etc., may cause abnormal mobility, and also downward displacement, or cardioposis.

**TREATMENT.**—The causative disorder should be ascertained and remedied. In emaciated people **dietetic measures** calculated to increase tissue nutrition are, of course, indicated, with instruction of the patient as to the prophylactic means he should adopt to prevent the occurrence of symptoms, by **suitable positions in bed**, the **avoidance of fatigue**, etc. All of these tend to reassure him and to promote recovery. **Quinine**, **strychnine**, and **iron** and very small doses of **thyroid gland**, **baths**, **mental rest**, **mild walking exercises**, and **outdoor life** are often useful. In portly subjects and in sufferers from gastroposis and enteroposis an abdominal belt, which by compressing the viscera tends to afford sup-

port to the diaphragm and overlying organs, sometimes suffices to arrest symptoms due to movable heart.

### DEXTROCARDIA.

Congenital and acquired types of dextrocardia are met with. In the former, the condition may consist merely of a simple rotation of the organ from left to right on its vertical axis, due to persistence of an embryonic condition, or, as is more rare, there may be a true transposition, whereby what is normally the left ventricle is situated on the right and all parts of the heart are similarly reversed. The latter is the type generally associated with general transposition of the viscera, the liver being on the left side and the stomach and spleen on the right. It can be differentiated clinically from congenital dextrocardia without transposition as well as from acquired dextrocardia (*dextroversio cordis*) by changes in the electrocardiogram—in particular, by inversion of all the waves in Lead I, sometimes with reduced excursions in Lead II.

When visceral transposition is incomplete, heart symptoms may result, *e.g.*, from pressure of the liver on the displaced heart lying above it. In general, however, congenital dextrocardia gives rise to little or no subjective disturbance.

Where the heart becomes displaced toward the right owing to left-sided pleural effusion or a fibroid tuberculosis of the right lung, the displacement is sometimes not sufficient to produce an actual dextrocardia, the heart occupying, *e.g.*, a median position. Dextrocardia does, however, at times result from such chest disorders, as in a case reported

by Bigard and Coste in which, after repeated attacks of pleuritis, the apex beat was displaced to a point 7 cm. (nearly 3 in.) to the right of the midline; in this case the border of the heart had become anterior, and there were no heart symptoms. Displacement of the heart to the left appears to be less common than that to the right, and is apt to induce pronounced symptoms, owing to kinking of the great vessels, which does not occur in displacement to the right.

Case of dextrocardia following a shrapnel wound of the chest and febrile chest infection in which cardiac dislocation was so great that the impulse was in the right axillary line and the left border 3 inches to the right of the midline. The second aortic sound was markedly accentuated. Birrell (Proc. Roy. Soc. of Med., May, 1921).

In some cases of rapidly acquired dextrocardia the result of chronic tuberculosis there was a first stage of torsion around a vertical and sagittal axis, followed by a migration of the whole heart to the right. Physical exertion caused dyspnea and tachycardia. The fingers were somewhat clubbed, and the red cells and hemoglobin showed a compensatory increase. The other mediastinal structures, as well as the trachea and esophagus, were also displaced to the right. P. Hecht (Beitr. z. Klin. d. Tuberk., Nov. 30, 1922).

### CONGENITAL HEART AFFECTIONS.

Apart from congenital dextrocardia, already referred to, there are numerous possible heart defects. These arise either from faulty development, constituting anomalies, or from prenatal endocarditis. Many of them are incompatible with postnatal life.

**VARIETIES.**—Patulous foramen ovale is the commonest of these con-

ditions. Indeed, estimates ranging from 20 to 78 per cent. of all human beings have been put forward as representing the frequency of incomplete closure of the foramen, where the mildest grades of the deformity—mere pinhole openings or oblique slits in the interauricular septum—are included. The larger openings may be of pencil or finger-tip size. The openings found in so high a percentage of subjects are usually of a valvular nature, and as such do not seem to interfere with perfect heart function. Where there is a continuous communication between the two auricles, the subject is typically a "blue baby," the cyanosis being ascribed to mixture of venous with the arterial blood in the greater circulation.

**Defective interventricular septum** may occur either as a perforation of the septum or a total absence of the septum; the latter condition results in a 3-chambered heart (*cor triloculare*). The condition of perforated septum is occasionally met clinically and has been termed *Roger's disease*. In such cases cyanosis and dyspnea may be absent when the subject is at rest. In general, however, cyanosis is a typical symptom, and there is also heard a loud, grinding, scraping murmur at the xiphoid cartilage, beginning early in systole and persisting through diastole. Perforate septum is usually complicated by other anomalies; yet has been found alone at autopsy in subjects 50 years of age.

**Persistent ductus arteriosus** (ductus Botalli) exists where the fetal opening between the aorta and left branch of the pulmonary artery has failed to close, as it does normally in the 1st

week of postnatal life. It is generally combined with pulmonary stenosis or narrowing of the aortic orifice. When it occurs alone, there may be no symptoms at all or intermittent cyanosis and dyspnea. A harsh murmur beginning in systole and persisting into diastole is typical, and is best heard at the 2d interspace, sometimes also over the scapula. A thrill over the base of the heart may be palpable.

**Valvular defects** are usually the result of fetal endocarditis, although there occur also abnormal valvular conditions that partake of the nature of anomalies, *e.g.*, supernumerary or reduced number of valve segments, particularly at the aortic and pulmonary orifices, or perforation of valve leaflets. Of the valvular conditions arising from endocarditis, **pulmonary stenosis** is the commonest, forming, indeed, over  $\frac{1}{2}$  of all congenital heart defects. These subjects are often "blue babies" at birth. The 2d pulmonary sound is weak and there is a harsh systolic murmur at the base, transmitted to the clavicle, often with a basal thrill. The need of increased myocardial activity to force sufficient blood through the stenotic channel leads to marked hypertrophy of the right ventricle and increased right transverse diameter of the heart. When uncomplicated, this lesion sometimes permits of life for many years in good health. But usually it is associated with other defects, such as defective interventricular septum or patent foramen ovale or both, resulting both in greater difficulty of diagnosis and marked uncertainty of survival beyond the first few years of life. Very many of the longer-surviving cases of pulmonary stenosis

eventually develop pulmonary tuberculosis.

A less common result of fetal endocarditis is **stenosis of the aortic orifice**, which is attended with hypertrophy of the left ventricle, but in which the prospects for postnatal life are poor. According to M. Abbott, congenital stenosis of the aortic arch at or near the insertion of the ductus arteriosus (coarctation of the aorta) is rather common as an anomaly, which in some cases does not shorten life. **Tricuspid or mitral stenosis or insufficiency** are possible results of prenatal endocarditis, insufficiency resulting where the morbid process has led to contraction of the valves.

**SYMPTOMS.**—The outstanding symptom in congenital heart disorders is cyanosis, which nearly always appears in the 1st week of life, and ranges in depth from a moderate duskiness to a dark violet or almost black discoloration. The abnormal color is most marked in peripheral structures such as the nose, ear lobules, fingers, etc., and is also noticeable on the oral mucosa. The coloration is increased by exertion or excitement, which may also bring on dyspnea. Cough may coexist, and the temperature may be subnormal. Clubbed fingers and thickened, claw-like nails are typical accompaniments. Locally, aside from the customary loud, musical murmurs, a moderate, non-progressive enlargement of the cardiac dullness is likely to be elicited. The murmurs typically differ from those of postnatal heart disease in being transmitted only to a small extent, upward and to the left. Mental development is often retarded, and convulsions may be noted. In coarctation of the aorta hypertrophy of

the left ventricle combined with reduced force of pulsations in the lower limbs as compared with the upper may be noted. X-ray examinations of the heart, electrocardiography and polygraphy at times yield suggestive information of assistance in the diagnosis. Where there is communication between the 2 sides of the heart a positive jugular pulse of mitral insufficiency may be of diagnostic assistance.

**TREATMENT.**—No curative treatment being known, the management of these cases consists largely of the exclusion of all factors that would tend further to impair the handicapped circulation. Careful **regulation of the patient's life** is indicated, with avoidance of sudden or excessive physical exertion as well as of nervous excitement. All possible precautions should be taken to **prevent intercurrent illnesses**, especially rheumatism, which is peculiarly likely to induce acute endocarditis in these cases. The patient should have plenty of **fresh air** and adequate **warmth** at all times, if necessary through removal to a warm, equable climate. The **diet** should be nutritious and easily digested. The more moderate forms of **hydrotherapy** may be resorted to.

In acute attacks of circulatory impairment, the **diffusible stimulants** and, in infants, a **hot mustard bath** have seemed the most effective measures. **Oxygen** may be tried. For more continuous effects, **digitalis** may be used, but the results from it have not been so favorable as might be expected. **Strychnine** has appeared superior to it in these cases.

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## HEAT EXHAUSTION AND THERMIC FEVER.

### HEAT EXHAUSTION.

By heat exhaustion is meant a condition of exhaustion brought on by great heat while the body is subjected to exertion, and which is characterized by vasomotor paralysis, prostration, and a low temperature.

**SYMPTOMS.**—The symptoms vary in nature and intensity. There is a feeling of marked weakness after exertion. Yawning and sighing are all that may be experienced in mild cases. If this condition becomes aggravated, the weakness lapses into intense prostration, with nausea, an unquenchable thirst, vertigo, pallor, and a cold perspiration. The patient sits or lies down in a cool place at this time, or he faints. Sometimes the loss of consciousness is only partial or evanescent, and the patient, especially if given a stimulant (aromatic spirit of ammonia, wine, etc.), may drop off into a quiet sleep, from which he awakens greatly improved.

In severe cases the patient suffers collapse, the pulse being then extremely weak and rapid, the perspiration very copious, and the temperature subnormal (95° to 96° F.—34.9° to 35.6° C.). Marked restlessness and muttering delirium are often observed. Cardiac failure may occur in weak or elderly individuals, but, as a rule, the patient recovers in a few hours under appropriate treatment, if the case is mild; while in the more severe cases, recovery may be delayed for a couple of days.

The sequelæ most frequently observed in cases of heat exhaustion are: undue sensitiveness to even moderate temperatures; acceleration

of the pulse and respiration; disorders of digestion; headache and vertigo; tenderness of the spine; chromatopsia; irritability of disposition, particularly recurring with the onset of warm weather. Epilepsy and disorders of locomotion and sensation have also been observed. Impairment of memory is often witnessed.

**DIAGNOSIS.**—Heat exhaustion, as distinguished from thermic fever, is marked by a subnormal temperature and feeble pulse. The syncope associated with cardiac failure or with concealed hemorrhage resembles heat exhaustion, being accompanied by a feeble pulse and subnormal temperature, which latter, however, is less marked in syncope. As the treatment of syncope and heat exhaustion is the same, the differentiation is not so vital as that between thermic fever and heat exhaustion. In the latter case diagnosis must be made, for the treatment of the two conditions is entirely opposite in character.

From acute alcoholism, heat exhaustion may be distinguished by the odor of alcohol and the previous history in the former condition.

As aids in differentiation we must always take into account the history of the affection, the mode of onset, the presence or absence of fever, the state of consciousness, the urine, skin, pulse, respiration, and the condition of the reflexes.

**ETIOLOGY AND PATHOGENESIS.**—Heat exhaustion is most often due to exposure of the head to the direct action of the sun. We meet, however, a large number of cases among stokers, laundry workers, steel workers and workers in rolling mills, and also persons who

are crowded together, as sweatshop workers, or who live in hot, ill-ventilated, insanitary rooms, buildings, or barracks where direct sunlight is absent. Grouping these, we must allow that heat exhaustion may be due to any condition in which an excess of heat accumulates within the body, and in which the body does not eliminate its noxious metabolic end-products, principally the acids. Abnormal heat is known to increase metabolism; and whenever the bodily heat production is in excess of the heat dissipation, symptoms of heat exhaustion are produced.

According to Hirsch, while heat is the primary factor, the immediate cause in the production of heat symptoms is a diminution of oxygen and retention of toxic elements. Vincent also holds to the toxic theory. Recent work, says Gordon, leads us to believe that there is some toxic element, having a paralyzing effect on the nervous system, which produces metabolic changes in the neurons, and that the effects of the sunstroke, according to the degree of auto-intoxication, will be manifested either in an ordinary attack of heat, exhaustion, or syncope, ending in unconsciousness or even death. If this be true, says Woolley, then heat exhaustion is an auto-intoxication engendered by substances formed within the body under normal conditions of heat retention. He surmises there is some chemical point common to sunstroke and shock, since heat accelerates chemical reaction and the symptoms of sunstroke and shock are similar, and the factor that seems the only probable one to him is the increased acid content of the tissues. This, in heat exhaustion, may be the result

of increased catabolic chemical action, influenced by heat. In all cases we are led to believe that there is a decrease in the alkalinity of the blood, and, likewise, a diminution in the oxygen content of the body.

The influence of the violet and ultraviolet rays does not occupy so important a position in the etiology of this condition as formerly, owing to the experiments of Freer, Gibbs, Bauer, Chamberlain, and Aron. Aron holds that the damage is done by the hyperthermia, produced by the heat rays (the red and ultrared) and not by the direct action of the sunlight.

The skin pigmentation of the negro allows utilization of the heat from without to such an extent that the organism does not need so many calories as the white man, while they stand exposure to heat very much better. Figueras (*Siglo Medico*, Mar. 26, 1921).

As to the effect of evaporation on heat dissipation, Hill has found that, so long as evaporation is active, high temperatures alone will not change the bodily temperature. The heat only produces serious results when evaporation is insufficient, as is shown by Aron's experiments with dogs, cats, guinea-pigs, and rabbits, where evaporation takes place through the respiratory tract. Heat exhaustion is frequently observed in cities during the summer heat, especially in persons in whom the powers of resistance have been weakened by overwork, ill health or alcoholism. It is also the variety of insolation usually observed in soldiers, and is especially marked in men unused to marching, or having malarial toxemia.

**PATHOLOGY.**—Heat exhaustion is, according to Wood, a condition in

which the heat center in the medulla is paralyzed by the excessive heat, with the result that heat is dissipated more rapidly than it is made.

**PROPHYLAXIS.**—The skin should be cleansed and kept clean, that evaporation may be free. The clothes should be loose and light, sufficiently thin to allow of a free circulation of air to facilitate evaporation. The diet should be light, and of easily digested food. Meats and rich food should be avoided. No alcoholic drinks should be taken. Plenty of cool (not iced) water or fruit juices is indicated. One should avoid fatigue and worry, and direct exposure to the sun. The windows of rooms and dwelling houses should be open, but shaded so as to exclude the heat rays without interfering with the free circulation of air. Electric fans increase evaporation from the body, by keeping the air in motion. Cool baths are refreshing and beneficial.

When the heat is intense, all work should be reduced to a minimum, and a midday rest in a shady place be taken if possible. Lemonade encourages the action of the kidneys, and the free use of water, internally, will favor intestinal elimination and diminish intoxication from fecal stasis.

**TREATMENT.**—The patient should be put in a warm bed, with his head horizontal or but slightly raised, and covered with an ice-bag. Hot-water bottles, heated irons, or quart bottles or cans filled with hot water should be wrapped in flannel and applied around the patient's body to augment the bodily heat. Meanwhile, friction to the extremities will be beneficial. The patient is now

covered with hot blankets, and is given hot stimulating drinks (hot milk, hot egg-nog, bouillon, coffee, etc.). If the patient cannot swallow, or is unconscious, hypodermic stimulation will be indicated (strychnine, caffeine, digitalin, camphorated oil, or aromatic spirit of ammonia, in from 10- to 20- minim—0.6 to 1.25 c.c.—doses, well diluted with whisky).

### THERMIC FEVER.

Thermic fever or heat apoplexy is an asphyxial form of heat prostration, characterized by sudden unconsciousness and high temperature. This variety of heat prostration is much less frequent than that previously described. True thermic fever is a common form of heat prostration, characterized by excessively high temperature, and differing from heat apoplexy only in that it is more intense.

**SYMPTOMS.**—In heat apoplexy dizziness, intense headache, the appearance of muscæ volitantes, marked throbbing at the temples, dryness of the skin, and dyspnea are the usual premonitory signs. Suddenly the patient falls, convulsions occur, followed, occasionally, by all the symptoms of cerebral hemorrhage, except the hemiplegia, but ending with cardiac paralysis.

In the majority of cases, however, this stage is not soon reached. Besides the first symptoms outlined, there is marked flushing of the face, which may become cyanotic; the breathing is stertorous; there are marked delirium, nausea, and vomiting, or, rather, retching, and the tongue is coated; epigastric cramps, oppression, rapid though full pulse, contraction of the pupils, hot and dry



skin, petechiæ, labored or stertorous breathing, and a mousy odor of the body have also been noted. In these cases the temperature may be subnormal at first, but it usually rises and may reach 105° or 106° F. (40.5° to 41.1° C.), exceptional cases very much higher (110° F.—43.3° C.).

Case in a negro of 64 years who complained of some vague pains in the loins and back. He had noticed also that his urine was red and deposited a heavy sediment. He had been a professional cook for twelve years. In an overheated kitchen he had often developed cramps in the muscles, especially the muscles of the calf and of the abdomen. These were described as hard, tonic contractions and intensely painful; when they occurred he was compelled to go out into a cooler atmosphere and lie down for an hour or two, after which he could resume work. He had found 2 or 3 glasses of lemonade the best adjunct to treatment. The condition was familiar to him and to all cooks, at least on Pullman diners, where in the hot weather the temperature in the kitchen sometimes rose to 150° F. (65.6° C.). He knew one man who had been seized with generalized tonic spasms on duty, and who had died in the hospital at the end of his run. The spasms tended to become worse and more frequent with time. Little was found on examination of this patient. His temperature was 98.3° F. (36.8° C.), his pulse 84. He had a coarse tremor in both hands, which was increased on voluntary movement. His reflexes were normal. His urine on standing deposited a heavy sediment of urates. Logan Clendening (Jour. Amer. Med. Assoc., May 7, 1910).

*Thermic fever* is attended by an excessively high temperature—sometimes 115°, 116° (46.1°, 46.7° C.), and even 117.8° F. (47.6° C.), as in the case observed by Lambert. This

means death, preceded by intense dyspnea, asphyxia, and coma, in the majority of cases unless proper treatment is promptly instituted.

In a considerable proportion of cases there are preliminary symptoms which, if accepted as warning, may prevent development of the more dangerous features—nausea, cramps, progressively increasing weakness, vertigo, blurred vision, intense headache, and cessation of the perspiration. If these symptoms do not cause the patient to realize that he is in danger, and to repair to a cooler spot, the active symptoms of thermic fever appear. The skin, from dry, becomes flushed, red, and burning; it may finally assume a bluish tinge, while the mucous membranes become markedly cyanotic.

A thermometer left *in situ* would indicate that the temperature is steadily rising, and, though perhaps subnormal at first, reaching down as low as 95° F. (35° C.), it may reach the temperature already mentioned. The pulse follows the temperature, and is at first full, bounding, and non-compressible, then becomes rapid; the number of respirations also corresponds with the temperature, varying from 20 to 60 in the minute. The eyes are watery and fixed, and the pupil is contracted.

Clonic spasms, alternating with rigidity, are often observed. There is moaning, delirium, and jactitation, unconsciousness usually accompanying these symptoms. The urine and feces are passed involuntarily,—though the secretions are sometimes suppressed,—and exacerbations of dyspnea, noticeable from the start, gradually assume the state of asphyxia, followed by death. A fatal

issue, however, does not always follow, and the use of appropriate means, especially the cold bath, often saves patients whose temperature has reached extraordinary limits.

The greatly depressed condition of the patients and the overvigorous measures employed to reduce the temperature have been the cause of pneumonia in these cases.

Among 160 cases of heat prostration at the Boston General Hospital, pneumonia occurred in 10.7 per cent. and was the cause of 20 per cent. of the 44 deaths. Though not more frequent after heatstroke than after heat prostration, in the former pneumonia was much more fatal. Of lobar pneumonia there were 7 cases with 2 deaths. Of bronchopneumonia there were 10 cases with 7 deaths. The greatest number of cases occurred between 20 and 30 years, but the severest mortality was in the sixth decade of life. Alcohol and arteriosclerosis were fatal complications. Erysipelas and empyema necessitatis were sequelæ in 2 of the cases. W. D. Reid (Boston Med. and Surg. Jour., Aug. 15, 1912).

A man had been haying all day when he fell unconscious, with Cheyne-Stokes breathing and convulsions. **Venesection** and **caffeine** afforded relief, but meningeal symptoms developed, with deafness and blood clots in the vitreous humor, entailing blindness. All the symptoms gradually subsided except the blindness. Attempts to remove the blood clots in the eye led to loss of 1 eye, but the clots in the other eye were spontaneously absorbed by the end of the year. Van der Kooi (Ned. Tijds. v. Gen., Oct. 11, 1924).

**ETIOLOGY.**—Excessive heat in any form is usually considered as the main factor in the production of insolation. It may not only occur in the street, but also in a boiler-room, a laundry, etc., showing that heat is the predominant factor. Heat exhaustion may be brought about by

excessive exertion under unfavorable conditions, while sunstroke is due to excessive heat and occurs during the hottest season of the year. The latter exhibits remarkable endemic characters, in that it is extremely prevalent in one locality, in another is totally absent, though the regions may be quite adjacent and under precisely similar climatic influences; again, its ravages in different years vary immensely and quite irrespective of heat.

The writer has made experiments on himself confirming Haldane's view that the essential factor in the production of heatstroke is the combination of excessive humidity and high temperature. It appears that in a moist atmosphere the heat-regulating mechanism of the body breaks down and the temperature begins to rise. The writer found that this occurred with a "wet bulb" temperature of 95° F. (35° C.). The rise of temperature increased progressively, being on the average 0.7° F. in the first hour, 1.2° F. in the second, and 1.5° F. in the third. All the experiments pointed to the conclusion that, once the balance of the mechanism of heat-regulation was definitely upset by high external temperature and almost total abolition of heat loss in evaporation, a vicious circle is established. The bodily temperature rises and as a result the oxidation processes, and therefore the production of heat, also increase and the body temperature rises still further. Once this process has been set going, it slowly but surely increases in speed. With this rise there was a great increase in the consumption of carbohydrates, which are the first to be sacrificed when the heat-regulating mechanism breaks down. Harvey Sutton (Jour. Amer. Med. Assoc., Nov. 21, 1908).

Direct measurements of the absorption and permeability of various tissues of the body in regard to heat, with calculations of the total radia-

tion of tropical sunshine, served to show that, even under favorable conditions of conduction and circulation, the total increase of temperature in the exposed skull is so considerable that an increased heating of the deeper layers, especially the cerebral cortex, through transmitted heat, appears to be possible. This secondary heating of the cerebral cortex, caused by transmission of the sun-rays absorbed by the cranial coverings, is presumably of greater significance in the origin of sunstroke than is the primary heating of the cerebral cortex through radiation. Schmidt (*Archiv f. Hyg.*, Bd. lxxxv, 1908).

According to Phillips, meteorological conditions predispose to sunstroke, and these involve high temperature, relative humidity, wind, and climatological characteristics, as well as the direct rays of the sun. The attack is no more dependent on high temperature and direct insolation than it is on low relative humidity.

The reduction of physical resistance to the action of heat upon the nerve-centers and a secondary disturbance of metabolism are probably at the bottom of these cases. Thus, fatigue,—mental and physical,—insufficient food, insanitary surroundings, and worry are all noted as predisposing factors. Alcoholism is particularly active in this respect.

Of 465 cases whose histories were known to Phillips out of a total of 841 cases, 30 per cent. were alcoholic, 50 per cent. moderate drinkers, and 20 per cent. teetotalers; while of 70 deaths, 60 per cent. occurred in alcoholic patients, 30 per cent. in moderate drinkers, and only 10 per cent. in teetotalers.

Males are more frequently affected than females, and children—though less frequently attacked—are not free

from the disorder, especially when the head is exposed to sun-rays.

The majority of cases occur in the afternoon, though cases are not infrequently observed at night, especially in poorly ventilated quarters. In stoke-holes, boiler-rooms, sugar-refineries, etc., where the heat is intense, heatstrokes may occur at any time.

**PATHOLOGY.**—After a study of 805 cases of insolation, Lambert and Van Gieson found that heat alone is not sufficient to explain all the clinical and pathological observations. The prodromal symptoms of sunstroke are those of acute functional disturbance, while the later symptoms, much more serious, point to grave changes in the blood and in all the nerve-centers, especially those of the latter which control the thermic mechanism of the body.

Van Gieson examined the brain and cord in several of Lambert's fatal cases, and found universal exhibition of acute degeneration of the neurons of the whole neutral axis. In the cerebral cortex and cerebellum the cells showed the same degenerated changes; the cells of the spinal cord were not so extensively involved. The toxic agency of the symptoms of insolation seems to be shown by the changes found in the ganglion cells. They were, in every way, similar to those produced by a number of other poisons, such as by alcohol, lead, etc., and by bacterial products.

The experiments by Vallin would tend to show that coagulation of the albuminoid bodies occurs. The toxemia would thus occur as a result of arrested metabolism. The blood is dark, though fluid, and the corpuscles are crenated. In the hyper-

pyrexial form leucocytosis and degeneration of the red corpuscles may also be noted. Extravasations in the peripheral tissues are often found, and the body undergoes rapid putrefaction.

The pathogenesis of the high temperature in thermic fever has been explained by Wood as follows: "There is in the pons or higher portion of the nervous system a center whose function it is to inhibit the production of animal heat, and in the medullar oblongata a center (probably the vasomotor center) which regulates the dissipation of bodily heat. Fever is due to a disturbance of these centers so that more heat is produced than normal and proportionately less thrown off. Let it be supposed that a man is placed in such an atmosphere that he is unable to get rid of the heat which he is forming. The temperature of the body will slowly rise, and he may suffer from a general thermic fever. If early or late in this condition the inhibitory heat center becomes exhausted by the effort which it is making to control the formation of heat, or becomes paralyzed by the direct action of the excessive temperature already reached, then suddenly all tissues will begin to form heat with the utmost rapidity, the bodily temperature rises with a bound, and the man drops over with one of the forms of *coup de soleil*."

Experiments on heat exhaustion conducted in rats, mice, and rabbits, which were exposed to the sun under glass or warmed in a dry oven. The effects were shown to be due to the heat rays and not the chemical rays. Young adult animals proved more resistant than either old or young animals. Fasting and bleeding diminished re-

sistance. Camphorated oil and caffeine were the only drugs that retarded death; ether, adrenalin, alcohol, morphine and kola proving valueless. Hemoclastic changes, consisting in altered coagulation, leucopenia and lowered blood-pressure, were detected. The animals became accustomed to heat only when the interval between heatings was longer than 16 days. With shorter intervals they were sensitized instead. The writer thinks some cases of malarial hemoglobinuria may be due to heat. Charles Richet, Jr. (*Jour. de physiol. et de path. gén.*, xx. 59, 1922).

According to de Santi, insolation is always attended with a tendency to cardiac arrest, but dependent on different causes. These may be classified as arising from intoxication by the products of muscular effort; from asphyxia; from a malarial infection called into activity by fatigue or heat. In the first form, that of intoxication by the products of muscular exertion, the victims are chiefly among soldiers unaccustomed to the fatigue of a march. The attacks occur when the temperature is high and the air is calm and humid, so that the cutaneous evaporation is small. Sambon has emphasized a microbic origin of insolation.

Study of the spinal fluid in a case of sunstroke. The patient, 26 years of age, after insolation began to present the signs of cerebral irritation, with a well-marked condition of mental confusion lasting for two weeks. The first lumbar puncture, on the sixth day, yielded a hemorrhagic fluid, which escaped in a continuous stream and contained numerous polynuclear cells. The following punctures yielded an amber-colored fluid without blood-clots after centrifugalization; there were lymphocytes instead of the polynuclear cells. On the nineteenth day of the disease, the puncture fluid was normal again.

The assumption of a process of intoxication is not required, to account for the effects of insolation. Dufour (*Comptes-rendus de la Soc. de Biol.*, vol. xlv, No. 5, 1909).

Not much is known of the pathology, chiefly because of the rarity of post-mortem examinations. Probably caused an autointoxication which in some cases induces multiple hemorrhages. T. H. Weisenburg (*Jour. Amer. Med. Assoc.*, June 29, 1912).

**PROGNOSIS.**—The prognosis depends not only on the severity of the case, but also upon prompt and appropriate treatment. Although some cases are almost instantly fatal, yet patients having a temperature of 110° F. (43.3° C.) have recovered under the prompt cold water treatment.

**PROPHYLAXIS.**—In addition to the suggestions offered under heat exhaustion, we would add that when persons are exposed to high heat, as in engine-rooms, factories, and in the hay-field, they should wear a **minimum of clothing**. **Cloths wet with cold water** may be **worn inside the cap or hat**. An abundant supply of **cool water** should be furnished for **drinking purposes**, as perspiration is favored by freely drinking of water. No alcoholics, and very little meat. **Fruits and vegetables**, with good **bread and butter**, should be the main portion of the **dietary**.

As the writer believes that the actinic theory of sunstroke is the correct one, he urges that soldiers' helmets should be **lined with orange red**; that their khaki coats should have a detachable **strip of orange red underneath the material along the spine**, and that the men should wear **shirts dyed this color**. Duncan (*Jour. of Tropical Med. and Hyg.*, March 1, 1907).

The writer ascribes the form of heatstroke experienced most fre-

quently by soldiers and workers in the fields to an intoxication by fatigue products, acting in conjunction with the heat of the sun. In subjects who are not performing an excess of muscular work, heat alone is incapable of causing death. Prophylaxis on this basis consists in insuring sufficient lung ventilation, oxygen destroying the toxic material and thus preventing heat stroke. For this purpose, the **thorax and shoulders** should be rendered as **free as possible**, **light clothing** of ample size being worn, without collar or tie. No burdens at the level of the kidneys should be permitted. At regular rest intervals, **forced respirations** should be practised, with the head thrown back and mouth open. The subject should carry with him a mixture of **water and vinegar**, which he should on occasion use to **moisten the face and snuff up into the nose** in order to stimulate the respiratory reflexes. Amar (*Presse méd.*, May 21, 1917).

**TREATMENT.** — Hydrotherapy and skilled and careful nursing seem to be chief factors in the treatment of insolation; frequent recording of the temperature, enabling the baths to be given at the earliest and, therefore, most effectual time; the use of the **ice tub-bath**, with constant and **general friction** of the entire surface, thus reducing the temperature in the shortest possible time, and being stimulating rather than depressing; the use of the same bath for all severe secondary elevations of temperature, and for the minor elevations, **sponge-baths of ice-water**, or of water at from 70° to 80° F. (21.1° to 26.7° C.), depending upon the individual case, and the repetition of these baths whenever the temperature is high enough to make them seem advisable.

At St. Vincent's Hospital, New York, the following method has given good results: The ambulances are

well supplied with **ice**, which is kept about the patient's head from the moment he is picked up until he enters the hospital.

Upon admission the patient is immediately stripped. His temperature, per rectum, is taken as he is being placed upon a raised stretcher or table.

The body of the patient is covered with a sheet, upon which are placed small pieces of ice. Large quantities are laid closely about the head. Ice-water from dippers, at a distance of from five to ten feet, are dashed with force upon the patient. This is continued about thirty or forty minutes.

The most efficacious stimulant, and one which has served to arouse when everything else has failed, was the pouring, from an elevation, of a fine **stream of ice-water upon the forehead**. As this treatment is very radical, it is continued for only one or two minutes at a time. In severe cases it is repeated several times, unless consciousness returns.

While this is going on, each patient, with very few exceptions, is given hypodermically 40 minims (2.5 c.c.) of the tincture of **digitalis** at one dose. Exception is in the case of the plethoric patients with high arterial tension. Upon such patients **venesection** is practised, and later tincture of digitalis is given in smaller doses.

The temperature is carefully watched; and when after hyperpyrexia it reaches 104° F. (40° C.), the patient is laid in a bed, covered with **blankets**, and **hot bottles** are placed about him.

When the temperature is reduced to 99° or 100° F. (37.2° or 37.8° C.) by bath, as is usually practised,

clinical history shows that it nearly always becomes subnormal—even falling at times as low as 91° F. (32.7° C.)—and leaves the patient in collapse. When the temperature is only reduced to 104° F. (40° C.) it will, in most cases, continue downward of its own accord.

Strychnine is never given. It has proved upon trial to cause convulsions or make them more violent. Convulsions are treated by **chloroform**.

When the secondary rise of temperature occurs, a sheet, wrung from ice-water, is spread over the patient, and kept wet until the temperature becomes normal. In some of the cases, where the secondary rise is very rapid, the entire **ice-and-water treatment** is repeated several times, or until the temperature remains normal. An **ice-cap** is kept upon the head from the time the temperature becomes normal until the patient is dismissed. This has been found of the utmost value.

In cases of prolonged unconsciousness patients are **nourished and stimulated** by means of the **stomach-tube**.

In extreme cases **hypodermics of whisky** are used.

As death seems the result of respiratory paralysis, **artificial respiration** is kept up for long periods of time—often half an hour or more. Surprising results are sometimes obtained.

The after-treatment consists of **light diet, stimulants, fresh air, the ice-cap**, and sudorifics, such as **ammonia**,—preferably the **spirit of Mindererus**,—in large doses.

Quoting a study of the treatment of thermic fever by Alexander Lambert (Med. News, July 24, 1897), the

writer points out that the lowest mortality recorded in that series of cases, 520 in number, was obtained by O'Dwyer in 197 cases treated at St. Vincent's Hospital by **affusions of ice-water combined with frictions**, until the temperature was reduced to 102° F. (38.9° C.), while the traditional ice pack and ice-bath gave mortalities ranging from 33 to 41 per cent. The fundamental principle of **hydrotherapy** in thermic fever is stimulation of the neurovascular mechanism of the body, which can be effected properly by ice-water affusions and frictions in place of the unscientific ice-bath or ice pack, which acts merely as an antipyretic of high potential. Simon Baruch (Med. Rec., July 1, 1911).

At the Boston City Hospital in 1911, the treatment in the *prostration stage, or heat apoplexy*, as described by W. D. Reid (Boston Med. and Surg. Jour., Oct. 26, 1911), consisted in **ice-cap, ice pack, cold pack, or sponge-bath**, according to the temperature, and **rest in bed**, with moderate stimulation, if there were signs of weakness.

In the *heatstroke type, or thermic fever*, there are four indications: (1) Reduction of temperature; (2) maintenance of cardiac action; (3) control of convulsions; (4) treatment of complications.

1. **Tub-baths and ice packs** were the choice in combating the high temperature. If the heart action was poor, the ice pack was always used, as the patient need not be moved as much. Vigorous **friction** seemed essential to good results. Also not a few cases were observed where too long continuance caused too great a reduction of temperature and a condition of collapse was induced. **Ice-water enemata** were used in a few instances, but, as a rule, a proper

use of external measures seemed sufficient.

2. Maintenance of cardiac action often required stimulation of a heroic type, mostly hypodermically, as the patients were generally unconscious. Generous use of **atropine** was practised for pulmonary edema, and **strychnine, camphor**, and various forms of shock enemata were directed at the failing heart. It was the general opinion among the house staff that the use of camphor, 2 grains (0.13 Gm.) in sterile oil by syringe, was of distinct value.

3. Convulsions were so frequent in the heatstroke cases that it became the practice toward the end of the so-called epidemic to administer a hypodermic of **morphine** and sometimes **hyosine**, with the plan of repeating the morphine in case convulsions, nevertheless, developed.

4. The treatment of complications as they occurred varied in no way from cases in which they were the primary disease. About 5 of these unconscious men required **catheterization** for retention of urine.

In the Carney Hospital of Boston, as given by L. C. Walker (Boston Med. and Surg. Jour., Oct. 26, 1911), **hydrotherapy** was practically the treatment used. Those cases with a temperature below 101° F. (38.3° C.) were unmolested with the exception of removing their clothing and substituting a sheet for covering. About one-half of these cases were given 1 dram (4 c.c.) of the **aromatic spirit of ammonia**, well diluted in water, by mouth, and these patients seemed to recover more promptly and to feel better than those patients who did not get this treatment. The patients with a temperature of from 101° to

103° F. (38.3° to 39.4° C.) were given a cool pack, that is, they were wrapped in a sheet soaked in water at the temperature it came from the hydrant. Those cases with a temperature of from 104° to 105.6° F. (40° to 40.8° C.) were placed in sheets and sponged with tap water for ten or fifteen minutes, and this was followed by sponging with ice-water for ten or fifteen minutes, and they remained in the wet sheets until the temperature of the patient had become nearly normal, when dry sheets were substituted after the patient had been rubbed dry. The method and length of treatment by **hydrotherapy** were determined by the elevation in the temperature.

Those patients having a temperature of 107° F. (41.6° C.) and over gave most concern. These patients, 10 in number, all had convulsions more or less marked in severity. These cases first were sponged with **tap-water**, followed by **ice-water** sponging, and then in a few minutes were rubbed with **ice**, and if the temperature had dropped 2° F. (1.1° C.) or more they were left in the **wet sheets** for about one-half an hour, after which time the same treatment was repeated until a nearly normal temperature was reached. In 2 cases the convulsions were also speedily relieved, but with the remaining 8 cases **chloroform** anesthesia was administered at the same time **hydrotherapy** was used. In 5 cases fifteen to twenty minutes of deep **chloroform** anesthesia relieved the convulsions, but a longer time was necessary in the highest temperatures, and the patient with the 110° F. (43.3° C.) temperature was under deep anesthesia for about two hours,

with short intervals of light anesthesia, in order to determine whether convulsions were relieved or not. **Morphine**, in  $\frac{1}{4}$ -grain (0.016 Gm.) doses, subcutaneously, repeated in a few minutes, was tried in 3 cases, but it seemed to have no effect in inhibiting the convulsions. As these high temperatures were accompanied by an irregular and poor quality pulse, **strychnine**, in  $\frac{1}{30}$ -grain (0.002 Gm.) doses, subcutaneously, was given and repeated in one-half hour in 2 cases with apparently good results. Large doses of **atropine**, subcutaneously, were given to 2 patients whose respirations were shallow and weak, but no benefit was noted. Only one patient had a chill following the hydrotherapy, and **blankets** and **hot-water bottles** soon relieved this condition.

In the milder form of thermic fever of infants, **sponging the body with hydrant-water** and the administration of more **water internally** are all that is required. In the severe forms a **bath** the temperature of which is not below 60° F. (15.6° C.) may be used; at the same time **friction** should be vigorously applied to keep the peripheral arterioles dilated. **Stimulants** may be given as required. In the hyperpyrexial forms it is well to make the skin intensely red, as by **nitroglycerin**, **friction** with towel or hand, or a **mustard bath**; then even **sponging with hydrant-water** will rapidly produce the desired result. **Spraying cold water** on the patient has been found to be the most effective treatment. The water should not be too cold. For convulsions and tonic spasms **chloroform** is important. Free perspiration should be induced as soon as possible. **Diuretics** act well by assisting the elimination of waste-products. **Nux vomica** should not be administered, as it may only be synergist to the toxin. **Water** should be given as soon as



possible and **freely administered** until convalescence. John Zahorsky (*Pediatrics*, No. 4, 1898).

As excessive loss of water in sweat is the main factor in the development of heatstroke **copious drinking** is important in its prevention. When after profuse perspiration the skin begins to dry off, heatstroke, that is, general arterial anemia, is impending. If relief is not soon obtained the victim becomes unconscious and hovers on the brink of the grave. In treatment, besides combating the high temperature and defective respiration and heart action, it is important to supply more fluid to the organism. This will protect the red corpuscles and prevent further escape of hemoglobin into the blood. That already in the blood should be removed by **venesection**. The writer advises removal of from 150 to 200 Gm. of blood from a vein, followed at once by **infusion** of **salt solution** through the same hollow needle. The lumen of the needle should be large enough to allow the escape of the morbidly thick venous blood. Senftleben (*Berl. klin. Woch.*, July 1, 1907).

In addition to the old classic treatments the writer advises the use of **lumbar puncture** not alone because of the similarity between the symptoms of sunstroke and meningitis, but because the cerebrospinal fluid is under increased tension, and in the severer cases it is albuminous and blood-stained with initial polynucleosis, followed later by a persistent lymphocytosis, an indication that the meninges are involved. When used early it lessens the headache and the somnolence. The operation should be repeated until the cerebrospinal fluid has become normal, macroscopically, microscopically, and chemically. The operation, simple and safe, has been used in the relief and cure of the sequelæ of sunstroke. De Massary, Lian, and Dufour speak highly of the results of this method. Mulot (*Amer. Med.*, July, 1912).

The best means to ward off edema of the brain or lung is by **venesection**;

the benefit is often striking after removal of 200 or 300 c.c. Venesection is indicated in the asphyxia form of heatstroke if the stagnation in the venous system and lungs persists longer than one or two hours. A. Hiller (*Deut. med. Woch.*, June 19, 1913).

Baruch shows that the mortality rate may be reduced to 6 per cent. by means of **forcible affusions of ice water**, stopped when the temperature falls to 103° F. He contrasts the various methods and mortality. The graduated bath (110° to 72° F.) has a mortality of 41.17 per cent.; the ice pack a mortality of 38.7 per cent.; the cold bath (70° to 50° F.) a mortality of 33.33 per cent.; the needle spray a mortality of 11.5 per cent. As hospitals and tubs are not always at hand, the chief point of interest may be how to reduce the temperature without ice water. The **clothing is removed from the chest and legs**. Water is then **sprinkled over the exposed parts of the body and evaporation produced by waving a coat rhythmically over the face, chest, and legs**. This stimulates the brain and nervous system. When the patient can swallow, **water** (not whisky) is **freely administered**. Editorial (*N. Y. Med. Jour.*, Sept. 19, 1914).

Following routine treatment for heatstroke recommended: Patients with a temperature of 103° F. or over are at once placed in a **tub of tap water**, the level of which is just high enough to cover the body except the head; the latter is supported in a hammock packed with **ice**. Vigorous **friction** is applied to the body by 4 or more persons; ice is added freely to the water, the friction kept up, and the rectal temperature taken every minute. Generally it recedes to 102° in 10 to 30 minutes; the patient is then wrapped in sheets or blankets and put to **bed**. The temperature usually continues to fall, frequently becoming subnormal, 95 to 97°. Cardiac stimulants, **strychnine**, **caffeine sodio-benzoate**, and **digitalis** or **strophanthus** are given freely, an **ice-bag** is placed at the head, and

**chipped ice** is given by mouth. **External heat** is applied for subnormal temperatures. For recurrences up to 103° **cold packs** and **alcohol sponges** are given; for those above 103° recourse is had again to the cold water friction bath. Recurrent temperatures cannot be reduced as easily as the initial high temperature. **Morphine, chloral hydrate, scopolamine, bromides** and **mechanical restraint** are used to control restlessness and convulsions. H. Gauss and K. A. Meyer (Amer. Jour. Med. Sci., Oct., 1917).

Of 22 infants in a Lyons Hospital, 16 suffered from heatstroke, 8 dying, during a hot wave. All were doing well when suddenly their temperature rose, and remained high, without an appreciable morning decline. The skin and the mucous membranes of the mouth and nose were dry, the pulse small and often uncountable, and restlessness was extreme, but there were no convulsions nor any gastrointestinal derangement. The infants who survived began to improve after 3 days, and recovered without sequelæ. A temperature above 86° F. is dangerous to young infants, especially when the humidity is high. Some infants owed their survival to **cool baths** for 10 to 20 minutes every 3 hours. Since then, the **hospital air** has been **cooled with ice**. Three zinc boxes, each containing 66 pounds of ice, were placed in the central aisle of the ward, and an electric fan above the box, playing on the ice, used to distribute the chilled air. Weil and Bertoye (Nourrisson, May, 1923).

In an atmospheric temperature of 105° on June 6, 1925, a white laborer, aged 50, was seen at a freight house lying unconscious and relaxed. His skin was hot and dry, and his cheeks covered with vomitus. At the hospital his rectal temperature was found to be 102°. He was packed in ice and a continuous colonic irrigation with ice water was used. Within 30 minutes the rectal thermometer recorded 93°. He became semiconscious and vomited. About 1 hour later his

temperature was 100.6°, and it continued to rise in spite of **cold sponge baths** to 105.6°. Then **ice packs** and colonic irrigations caused another sudden drop to 94.6°, which later fell to 93.6°, although he was wrapped in dry blankets. A third rise to 105° and drop to 97° occurred later. He had a series of tetanic convulsions lasting practically through the night. During the next few days there were several lesser rises in temperature, all responding to ice packs, and all showing the same tendency for the temperature to continue to drop after stopping the pack. Although conscious most of the time, he was very irrational, excitable, and had hallucinations. For two days he had to be **strapped** to his bed. He developed a mild acute bronchitis which lasted 1 week. His mental symptoms cleared on the 7th day. F. S. Hopkins (Boston Med. and Surg. Jour., July 30, 1925).

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## HEMATOLOGY AND SERUM REACTIONS.

—By the term *hematology* is meant the aggregate of our knowledge concerning the blood, while *serum reactions* refer to diagnostic tests based upon the examination of the blood-serum for various biological constituents.

The blood is both a tissue and a fluid. It is composed of plasma and blood-corpuscles.

The blood-plasma is made up chiefly of water, with a small percentage of serum albumin, serum globulin, glucose, inorganic salts, fibrinogen, and extractives, and containing in solution small amounts of oxygen and nitrogen and variable amounts of carbon dioxide. The corpuscles are composed of water, oxyhemoglobin, lecithin, salts, fibrin ferment, blood-plates, hemoconia, and the stroma. The composition of the blood, as given by Simons, is as follows:—

Plasma .....	520 parts.
Water .....	477.37 parts.
Albumins .....	35.88 parts.
Extractives .....	2.39 parts.
Inorganic salts .....	4.36 parts.

Corpuscles .....	480 parts.
Water .....	276.90 parts.
Oxyhemoglobin .....	193.90 parts.
Stroma .....	9.20 parts.

**METHOD OF OBTAINING A SPECIMEN FOR EXAMINATION.**—Before making a puncture for the withdrawal of blood it is best to determine the absence of hemophilia.

The best locations for making the puncture are the lobe of the ear and the finger. In a young child the great toe may be used. The advantages of making the prick in the lobe of the ear are that the patient cannot see what is being done, and that the skin in this place is thin and not very sensitive. The advantages of using the finger are the absence of hairs, and the ability of placing the hand in a convenient position.

The part in which the puncture is to be made should be washed thoroughly with soap and water, then alcohol, and finally ether. The parts should be massaged, or rubbed with a towel previous to the puncture. For making the puncture a Daland, Hagedorn, Francke, or a glover's needle, or the half-point of a new sharp-pointed steel pen, may be used. The instrument used should be thoroughly sterilized by passing it through the flame of a Bunsen burner or alcohol lamp.

After the application of a broad rubber band to the finger of the patient, it is held firmly between the index finger and thumb of the operator and the stab made quickly and fairly deep into the tip. The first drop of blood exuding should be wiped away and the second one used. The part should not be pinched, but the blood allowed to flow naturally. If the lobe of the ear is used the stab is made into the lower edge parallel to the surface, if the lobe is thin; if it is thick, stab may be made on the surface.

Larger quantities of blood may be withdrawn by means of wet cups, or a sterile syringe may be used to withdraw the blood from a dilated vein. Venesection may be done if necessary.

**COLOR.**—The color of the blood is due to the hemoglobin, an albuminous substance which is found in the red blood-corpuscles. It is combined with oxygen

in the arterial blood, giving a scarlet-red color to the blood; while in the venous blood there is a mixture of hemoglobin and oxyhemoglobin, giving a bluish color. The variations in color are due to the relative proportions of oxygen and carbon dioxide in the two types of blood.

In anemia the blood is pale and watery. In severe leukemia, it may have a milky appearance. In diabetes it is buff-colored. Admixture of blood with water, saline solutions, urea, ether, snake venom, mushroom extract, etc., causes the blood to lose its opacity by dissolving out the hemoglobin from the cells; this is called hemolysis or "laking." Certain poisons also change the color; thus, in coal-gas poisoning the blood is cherry-red, while in poisoning by potassium chlorate or hydrocyanic acid it has a chocolate hue.

**TASTE.**—The blood has a salty taste.

**ODOR.**—The blood has a characteristic odor, which differs in different animals. This odor is due to certain volatile fatty acids; it is accentuated by the addition of concentrated sulphuric acid (Barruel's test).

**REACTION.**—The blood is alkaline in reaction. Its reaction may be roughly tested with litmus paper. This is first moistened with a saturated solution of common salt and is next drawn through the blood. The red corpuscles are then washed off in the same solution. The alkalinity diminishes rapidly after the blood is shed. This is due to certain acids which form. Normally, the degree of alkalinity varies from 325 to 360 mg. of sodium hydrate for each 100 c.c. of blood. This can be determined by titration.

Notation of the reaction of the blood is now commonly made in terms of the *hydrogen-ion concentration* (pH). In respect of this property, 7.0 expresses a neutral reaction. As alkalinity rises, this figure becomes greater, and *vice versa*.

**Alkali Reserve and Acid-base Equilibrium.**

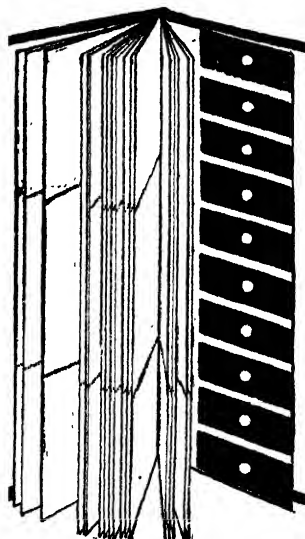
—Though acid products of metabolism, particularly carbonic acid, are constantly being poured into the blood, its relative alkalinity is maintained by what has been termed the *alkali reserve*, which is based on the bicarbonates, alkali protein compounds, and alkali phosphates in small amount.

As pointed out by K. Meier, disturbances of acid-base equilibrium may arise not only through abnormal accumulation of acids or bases in the blood, but also through failure of the normal neutralizing and eliminatory processes (dependent upon the liver, kidneys, blood, and tissue cells generally) or through failing stimulability of the respiratory center. The carbon dioxide tension (reduction of which measures the extent of an acidosis) increases after ingestion of food and during sleep, and is decreased by muscular work and during pregnancy. Barometric changes also affect it. The reaction of the blood tends toward acidity on a meat diet and toward alkalinity on a vegetable diet. Decrease of alkali reserve occurs in all renal diseases with reduction of secreting parenchyma, the urine, however, not being very acid in spite of the acidity of the blood because the kidneys are failing to excrete the acid completely. In cardiac dyspnea there is normal alkali reserve, and the carbon dioxide tension in the alveolar air may or may not be increased. In febrile diseases, anaphylactic shock, and epileptic attacks the alkali reserve is decreased.

**Alkali Reserve Determination.**—The clinical method of *Lery, Rowntree and Marriott* requires the use of a collodion dialyzing sac, prepared with a solution of 1 ounce of collodion in 500 c.c. of a mixture in equal parts of ethyl alcohol and ether. A small test-tube is taken and by manipulation, coated evenly within with the collodion mixture. It is then inverted until all odor of ether has disappeared, rinsed repeatedly with cold water, the collodion loosened around the rim of the tube with a knife, and cold water introduced carefully with a pipette between the collodion and the tube, thus freeing it from the latter. In making the blood test for alkali reserve, 3 c.c. of blood or serum is run into the dialyzing sac, previously washed inside and out with an 0.8 per cent. solution of C. P. sodium chloride. The sac is next lowered in a slightly larger test-tube containing exactly 3 c.c. of the 0.8 per cent. salt solution until the levels of the fluids within and without are the same. Five minutes later the sac is taken out, and 5 drops of 0.01 per cent. aqueous phenolsulphonephthalein solution

mixed with the salt solution remaining in the test-tube. The resulting color is then compared with a series of standard color tubes (prepared with varying mixtures of solutions of potassium dihydrogen phosphate and disodium hydrogen phosphate) from which the hydrogen ion concentration of the specimen can be read off.

Normally, oxalated blood yields figures varying from 7.4 to 7.6, and blood serum, from 7.6 to 7.8. Corresponding figures of 7.3 to 7.1 and 7.55 to 7.2 indicate the presence of acidosis.



Tallqvist's hemoglobinometer.

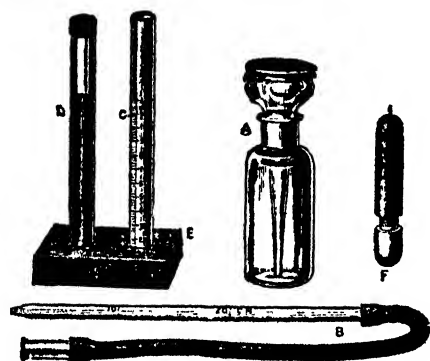
**SPECIFIC GRAVITY.**—The normal specific gravity of the blood ranges from 1.055 to 1.065, the average being 1.060. Different physiological conditions cause a variation in the specific gravity, as age, sex, exercise, the process of digestion, the amount of hemoglobin, and the time and temperature at which the determinations are made.

**Hammerschlag's Method of Determining the Specific Gravity.**—Benzol and chloroform are used for this test. The specific gravity of the former is 0.889, and of the latter, 1.526. These two are combined, so that the mixture has a specific gravity of from 1.05 to 1.06. A puncture is made in the finger and a drop of blood is allowed to fall directly into the solution. It is brought into suspension by the addition of either

the benzol or the chloroform and, when it remains absolutely stationary in the center of the perpendicular axis of the solution, the specific gravity of the mixture is taken by means of an hydrometer. The reading will represent the specific gravity of the blood.

#### ESTIMATION OF THE PERCENTAGE OF HEMOGLOBIN.—

There are many kinds of hemoglobinometers in use, and among those most frequently used may be mentioned the Tallqvist, Gower, Sahli, Haldane, Oliver, Gartner, Hayem, Dare, Henocque, Fleischl; the spectrophotometer of Hüfner, the colorimetric double pipette of Hoppe-Seyler, and the



Gower's hemoglobinometer.

methods of Webelthan and of Lange-meister, for laboratory use.

**Tallqvist's Method.**—Although less accurate than the other methods, this method is frequently used. The instrument consists of a booklet and a color scale and is most convenient, as it can be carried in the pocket. After making the puncture in the finger, a drop of blood is allowed to fall on one of the leaves (of filter paper) from the booklet. This is then drawn along the color scale until the drop of blood and one of the shades correspond and the percentage is read from the color scale.

The comparison between the blood droplet and the color scale must be made at once, as changes take place in the hemoglobin when dried.

**Gower's Method.**—This apparatus consists of two tubes, a graduated pipette, and a dropping bottle. The mixing test-tube is graduated from 5 up to

120, so that when 20 c.mm. of normal blood are diluted with water up to the 100 mark with water the color should exactly correspond with that of the contents of the other tube, which contains a glycerin jelly tinted with picocarmine in such a way as to represent the color of the normal blood.

A small quantity of water is placed in the graduated mixing tube, and a few drops are drawn into the graduated pipette. The puncture is made, after having thoroughly cleansed the finger with alcohol, then ether, and wiped away the first drop of blood. The blood is then drawn up into the graduated pipette to the 20 c.mm. mark. The tip of the pipette is placed in the water in the bottom of the graduated tube, the blood blown out and allowed to settle to the bottom. The pipette is washed out several times by drawing up the supernatant fluid and blowing it out again. The blood and water are then thoroughly mixed by shaking.

The two tubes are now placed side by side against a piece of white paper held in the light, and the colors compared. Water is added, drop by drop, to the diluted blood, mixing after each addition, until the color in the two tubes exactly corresponds. The percentage of hemoglobin is expressed by reading off the height of the column of diluted blood.

**Sahli's Method.**—This method is similar to the one just described. The standard tube contains a solution of acid hematin in glycerin and water, corresponding to a 1 per cent. solution of normal blood, and has a brown color. A decinormal solution of hydrochloric acid is used to convert the hemoglobin of the blood into acid hematin. A small amount of hydrochloric acid is placed in the graduated tube and the blood drawn up. This will turn brown. About one-half hour is allowed to pass; then the diluted acid is added until the color of the mixture in the graduated tube exactly corresponds with that of the standard tube. The percentage of hemoglobin is then estimated.

**Fleischl's hemoglobinometer** consists of a cylindrical cell for holding the prepared blood, a graduated wedge-shaped piece of colored glass with which to compare the

solution of blood, a stand with rack and pinion and a circular opening into which the cell is placed, and a capillary tube for measuring the quantity of blood required.

1. The cell is a cylindrical metallic chamber, divided by a fixed partition into two equal compartments, open at the top, and closed at the bottom by a base of glass. One of these compartments is to be filled with distilled water, the other with the proper quantity of blood dissolved in distilled water.

2. The colored glass wedge, tinted with Cassius's golden purple, is fitted to a metal frame, so that it can be adjusted in the stand and moved from side to side by the rack and pinion. When in position the glass wedge moves directly beneath that compartment of the cell which contains the distilled water, thus enabling one to compare the color of the glass with that of the dissolved blood, which fills the adjoining compartment of the cell. The glass wedge is graduated from 1 to 100, the figures representing the percentage of hemoglobin in the specimen of blood as compared to normal blood containing 13.7 per cent. hemoglobin. Thus,  $100:13.7::p:x$ , where  $p$  represents the reading on the scale and  $x$  the corresponding amount of hemoglobin.

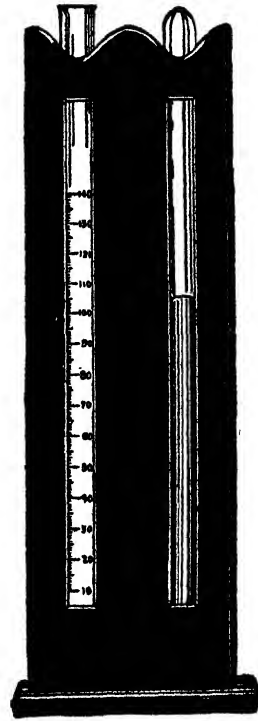
3. The stand, besides having a support for the glass wedge and frame, has a white gypsum mirror below, which furnishes the diffused light required in the test, and a circular recess on top for the reception of the cell.

4. The capillary tubes are mounted in metal handles, and are carefully adjusted to hold the proper quantity of blood. The size of these tubes varies, and the capacity of each is stamped on the handle. Each tube must be used only with an instrument bearing the same number stamped thereon.

**Technique.**—The capillary tube is cleaned, first, by using distilled water, then ether, and dried by forcing air through it. Both compartments of the cylindrical chamber are filled three-fourths with distilled water. The puncture having been made, with previous cleansing and drying of the part, in the lobe of the ear or the tip of the finger, and a small drop of blood having appeared, one end of the capillary tube

is applied to the apex of the drop (not immersed in it), whereupon the tube will instantly fill with blood.

Any blood clinging to the sides of the tube must be removed. This measured quantity of blood is then dissolved in one chamber of the cylindrical vessel by plunging the tube into the water, moving it back and forth in the direction of its long axis, and finally rinsing with a few drops of distilled water. A medicine drop-



Sahli's hemometer. (Greene.)

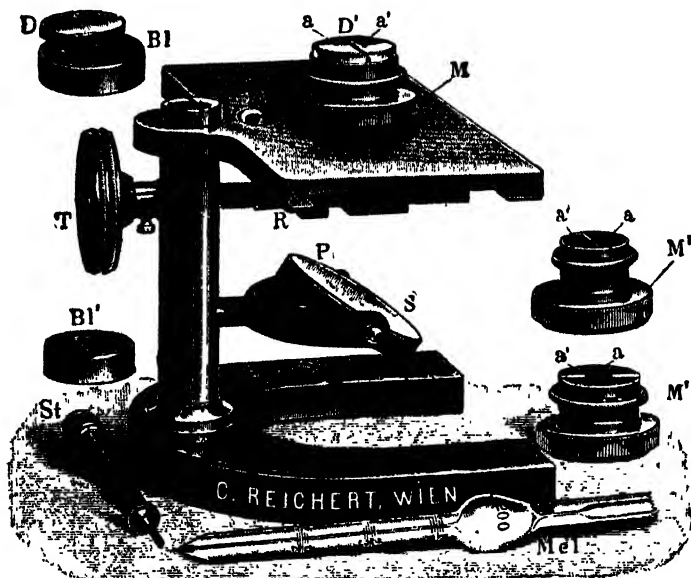
per with a fine point is then used for completing the filling of both compartments. Do not stir, as that might cause an overflow.

The cell should be in position on the stand, with the wedge in place, before completing the filling. The color of the glass wedge is intended for use with yellow light, which is derived from a candleflame, preferably large and placed within 6 inches of the reflector. In reading the percentage use a tube 8 to 10 inches long and  $1\frac{1}{2}$  inches in diameter, preferably blackened on the inside, placing it on the stand surrounding the vessel

to cut off any overhead light. Set the stand so that the partition of the cell is in line with the vertical axis of the eye, and adjust the candle and reflector to give the best possible light. Closing the eye on the side toward the candle, apply the other to the tube, and turn the screw quickly until the color of the two compartments appears the same. Rest the eye for a few seconds and look again. Repeat until, to the rested eye, the colors are identical. Then read off the percent-

construction, but different in its calibration, and the diluent used is 0.1 per cent. sodium carbonate solution, which dissolves the stromata of the red cells and furnishes a clear solution.

An estimation of the percentage of hemoglobin is very important in some conditions. Both the presence and degree of an anemia may be estimated by the estimation of the hemoglobin. The estimation of the hemoglobin may also show the presence of a severe septic condition



Fleischl-Miescher hemometer. (Webster.)

*E*, stage; *T*, milled head, which moves the color scale; *m*, opening in stage, through which the instrument is read; *M*, mixing cell; *D'*, cover glass; *D*, cap; *PS*, gypsum mirror, from which the light is reflected; *Mel*, diluting pipette.

age. Inasmuch as high percentages of hemoglobin are more easily read than low ones, in cases where a low percentage is known to exist it is well to take two or three times the usual amount of blood, using a dry tube each time, and calculating the percentage accordingly.

A later form of this apparatus, devised by Miescher, has the same stand and same scale principle, although the scale is standardized differently and graduated on a different basis. It differs in the method of measuring and diluting the blood, in the form of the comparison chamber, and in the meaning of the graduation of the scale. The diluting pipette is similar in

in which there is usually a marked and rapid fall of the hemoglobin content. Again, a decrease in the percentage of hemoglobin from day to day may indicate the presence of hemorrhage. In malaria there is also a decrease in the percentage of hemoglobin, and the fall is sudden and rapid in the early stages.

A relative diminution of hemoglobin is known as oligochromemia or as achrocythemia, and is usually associated with a decrease in the number of erythrocytes (oligocythemia); in chlorosis, however, the diminution of hemoglobin is an absolute reduction, each cell showing less hemoglobin.

**COLOR-INDEX.**—By this is meant the percentage of hemoglobin present in each red cell. It is found by dividing the percentage of hemoglobin by the percentage of red corpuscles.

There may be a relative or absolute change in the amount of hemoglobin present in each red cell in different diseases.

#### TOTAL VOLUME OF THE BLOOD.

—By the older methods the weight of the blood was estimated as equal to  $\frac{1}{13}$  of the body weight. By the method of Haldane and Smith its volume was found to range between  $\frac{1}{30}$  and  $\frac{1}{16}$ , being proportionately less in the obese. The *Congo red method*, introduced by Keith, Rowntree and Geraghty, consists in injecting intravenously 10 c.c. of 1 per cent. Congo red solution. From the vein of the other side 6 to 8 c.c. of blood are taken and the serum used for comparison with a 0.01 per cent. Congo red solution in the Autenrieth colorimeter, from which the volume of the entire blood mass can be calculated. By this method the average blood content of the body proved to be 7.5 per cent. of the body weight.

#### COAGULATION OF THE BLOOD.

See COAGULABILITY OF THE BLOOD.

**ESTIMATION OF THE CORPUSCLES.**—A special apparatus is necessary for the estimation of the corpuscles. The best apparatus for this purpose is the Thoma-Zeiss hemocytometer. This consists of two pipettes, for diluting the blood, and a counting chamber.

Each pipette has a long, graduated stem, above which is a small bulb containing a little glass ball. The stem of the pipette is divided into 10 parts by transverse lines. On the one for counting the red blood-cells (erythrocytes) the middle line is marked 0.05, and the upper end near the bulb, 1. The line just above the bulb is marked 1.01.

The pipette for diluting the white blood-cells (leucocytes) is of larger caliber than that used for the erythrocytes, and the line above the glass bulb is marked 11.

The counting chamber consists of a thick, flat plate of glass, in the center of which is cemented a square piece of glass having a circular opening in its center. A small circular disc is cemented to the glass slide, so that it is in the center of

the opening in the square plate. This disc is just  $\frac{1}{10}$  mm. thinner than the square plate and the edges do not come into contact with the margins of the circular opening, thus forming a "moat" around the circular disc.

The depth of the chamber, formed by the application of a special cover glass over the circular opening, is exactly  $\frac{1}{10}$  mm. Fine microscopic lines divide the center of the floor of this chamber into minute squares. There are 16 large squares separated from each other by double ruled lines, and each large square is again divided into 16 smaller squares. There are, therefore, 256 small squares, and if we count the small squares between the large squares there is a total of 400 small squares. The space between each square and the cover glass is exactly  $\frac{1}{10}$  mm. in depth,  $\frac{1}{20}$  mm. in length, and  $\frac{1}{20}$  mm. in width, so that its cubic capacity is  $\frac{1}{4000}$  c.mm.

**Diluting Fluids.**—For the proper examination of the blood, it must be diluted with a solution which will not only prevent coagulation and hemolysis, but will preserve the corpuscles intact.

If both leucocytes and erythrocytes are counted in the same specimen only one diluting fluid is necessary. Toisson's solution is here given:—

Sodium chloride .....	1 Gm.
Sodium sulphate .....	8 Gm.
Neutral glycerin .....	30 c.c.
Distilled water .....	160 c.c.
Methyl violet, 5B .....	0.025 Gm.

When used, a few minutes only are necessary to stain the white blood-corpuscles so that they may be easily distinguished from the red cells. Occasionally this fluid hemolyzes the red cells and thus invalidates the count. It is, moreover, easily infected with yeast spores, which develop rapidly in it; hence, the fluid should always be filtered before use, and, as each filtration weakens it, it gradually becomes useless and must be replaced by a freshly made solution.

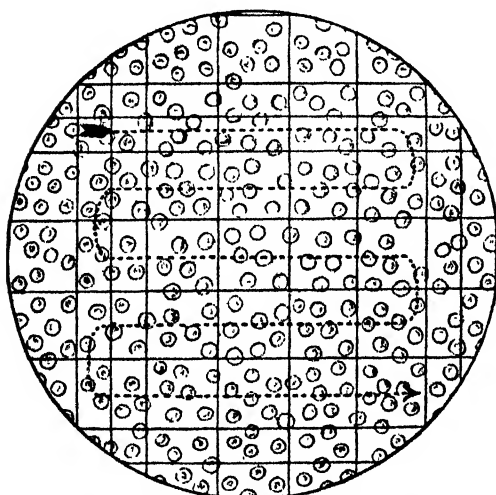
If the red and the white corpuscles are to be counted separately then two diluting fluids are necessary. Hayem's solution may be used when counting the red blood-cells. This contains:—



Mercuric chloride .....	0.5 Gm.
Sodium sulphate .....	5.0 Gm.
Sodium chloride .....	1.0 Gm.
Distilled water .....	200.0 c.c.

For diluting the blood for counting the white blood-cells a 0.3 to 0.5 per cent. solution of glacial acetic acid may be used, to which is added gentian violet to bring out the white cells more clearly. This solution destroys the red cells, leaving only the white; it must be freshly prepared.

**Technique.**—After making the puncture in the finger or ear the blood is drawn up



Da Costa's plan for the counting of corpuscles.  
(Webster.)

in the pipette to the mark 0.5 or 1, according to the dilution one wishes to have. The tip of the pipette is carefully wiped free of blood with the fingers and is then immersed in the diluting fluid, which is drawn up into the tubes by suction to the mark 1.01. After having drawn up the diluting fluid, the pipette is removed, the fingers placed over each end of the pipette, and it is then thoroughly shaken so that the blood and diluting fluid are thoroughly mixed.

If the estimation is not to be made immediately, remove the small rubber tube from the pipette and stretch a rubber band over both ends so that both openings are covered. All examinations should be made within a few hours.

Thoroughly clean both slide and cover

glass with water and then dry. Do not use alcohol or xylol, as these are liable to dissolve the cement and thus loosen the small glass plate and disc.

Blow out the portion of diluting fluid in the capillary part of the pipette and wipe the tip. The next drop of the diluted blood is allowed to fall in the center of the small circular disc. The cover-glass is very gently applied and when in place gentle pressure is made at the corners. Should any of the diluted blood run over the edge of the circular disc into the surrounding "moat" or should air bubbles be present the slide must be cleaned and the whole procedure repeated. Allow a few minutes to pass before beginning to count, so that the corpuscles may settle to the bottom of the chamber.

After placing the slide under the microscope examine first with the low power. Having located the small squares and gotten them into the center of the field turn on the high power and screw it downward until it almost touches the top of the cover glass. Looking down the microscope, focus slowly upward until the lines come into view. Should the lines be very indistinct, they may be brought out by rubbing gently with a soft lead pencil before dropping on the diluted blood.

**Counting the Erythrocytes.**—Move the slide so that one corner of the ruled area is under the eye. It is preferable to begin at the left upper corner. One hundred small squares are to be counted. There are 16 small squares in 1 large square, so that 6 large squares and then 4 small squares should be counted. It is best to count the squares in different parts of the ruled area and thus be sure that 1 large square is not counted twice.

Begin by counting the corpuscles lying in the center of the small square and then those on the lines. It is best to count those corpuscles lying on the upper and left-hand lines as being in the square, disregarding those on the lower and right-hand lines.

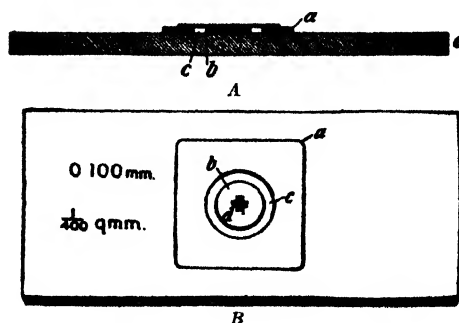
The leucocytes are distinguished because they are more refractile and are slightly tinged if a stain has been used in the diluting fluid.

**Calculation.**—The average number of corpuscles in each square is first gotten by adding together the corpuscles in all the squares counted, and then dividing by the number of squares counted. The capacity of one square is  $\frac{1}{4000}$  c.mm. If the dilution used is 1:100, the average number of corpuscles found in each square is really contained in  $\frac{1}{4000}$  of  $\frac{1}{100}$  of undiluted blood; therefore, to determine the number of corpuscles in 1 c.mm. of undiluted blood the average number of cells per square is multiplied by 100, and that product again by 4000.

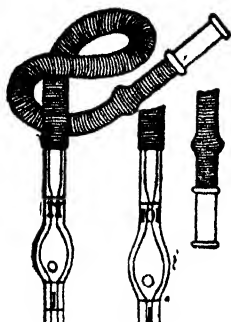
**Example.**—Suppose after counting 100 squares the total is 1500 corpuscles, then the average per square is 15. If the dilution was 1 in 100 multiply by 100 and that product by 4000, which equals 6,000,000. This would be the number of red corpuscles in 1 c.mm. of undiluted blood, a normal count.

**Counting of Leucocytes.**—The white cells are best counted in the same speci-

field is secured in a special chamber originated by Zappert by which the original ruling is so modified that a counting surface of 9 sq. mm. is afforded. This modification has been improved by Türk in such a way that the 4 large corner squares, each of 1 sq. mm., are sub-



Counting chamber of the Thoma-Zeiss hemocytometer. A, profile view; B, face view; a, wall of cell; b, central disc; c, groove about disc; d, ruled surface.



II



I, leucocytometer; II, erythrocytometer of Thoma-Zeiss hemocytometer.

men as the red, but in order to count enough leucocytes to insure accuracy in the specimen prepared for counting the red cells a much larger field must be traversed than is outlined in the ordinary Thoma counting chamber. This larger

divided into 16 smaller squares, each of which is equal in area to the total 25 smallest squares of the Thoma chamber. The 16 central squares are used in counting the erythrocytes, while the entire area may be used in counting the leucocytes. It is usually sufficient to count the white cells in a single drop, but for accuracy 3 or even 4 drops had better be examined. The calculation by this method is very simple. As the entire ruled area of the Türk chamber covers an area of 9 sq. mm., each equal to the central area used in counting the red cells, we have the equivalent of 3600 small squares in the ruled surface. Multiply this figure by the number of drops used, to obtain the total number of small squares covered by the count. Thus, if 108 leucocytes were counted in 2 drops (7200 small squares) and the dilution was 100 then we have the equation

$$\frac{108 \times 100 \times 4000}{7200} = 6000.$$

We may arrive at the result in another way by considering each square millimeter of the surface of the Türk chamber as a unit. If, then, the number of cells counted in 2 drops (18 units) be 108, divide this number by the number of units counted,

18, and multiply the result by 10 (the cubic contents of each unit) and then by the dilution (100)—

$$\begin{array}{r} 108 \times 10 \times 100 \\ 18 \\ \hline = 6000. \end{array}$$

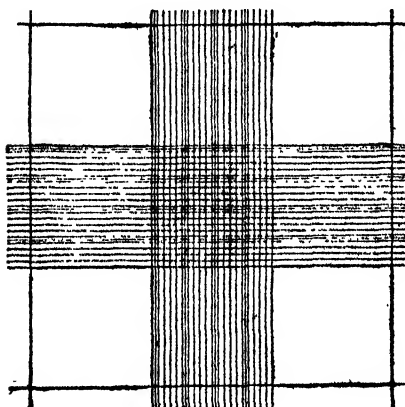
It may be found desirable in counting the leucocytes to use the special leucocytometer supplied with the Thoma-Zeiss apparatus, as this gives a lower dilution and therefore more leucocytes to the surface counted. In using this pipette, the blood is drawn to the mark 1 and the diluent (1 per cent. acetic acid) added to

pumped or blown through the pipette until it is thoroughly dry.

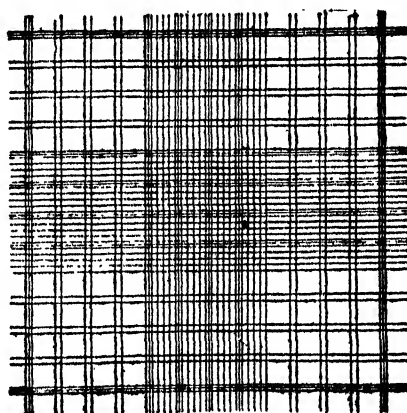
If the blood has coagulated within the pipette, the tube may be placed in a test-tube containing hydrochloric acid and allowed to remain there for twenty-four hours. It should then be cleaned in the same way mentioned above.

#### DIFFERENTIAL BLOOD-COUNT.—

The cover-glasses used for making a blood-smear should be square, thin, and thoroughly cleansed, first with soap and water, and then with ether. They may then be kept in alcohol, and wiped dry with tissue paper when they are to be



Zappert ruling.



Türk's ruling.

the mark 11. This diluent destroys the red cells and brings out the leucocytes. If a Türk chamber is used, a count of at least 250 is necessary, better more. The calculation is the same as before. If 300 cells were counted in 5 sq. mm. of ruled surface, the dilution being 10, we have

$$\begin{array}{r} 300 \times 10 \times 10 \\ 5 \\ \hline = 6000. \end{array}$$

The diluent should be fresh and free from yeast spores.

After making a blood-count the pipette used should be cleaned immediately. All fluid in the tube should be blown out and distilled water then drawn up into the pipette. This is blown out and absolute alcohol drawn in. This is in turn expelled and ether drawn up into the tube. The ether is finally blown out and air

used. This is to insure the proper spreading of the blood between the surfaces of the glasses, as the presence of any fat or dust particles will prevent it.

A cover-glass is taken between the thumb and index finger of the one hand, it being held by the opposite corners. A second cover-glass is taken between the same fingers of the other hand, but is held by the adjacent corners.

The part from which the blood is to be taken is prepared and the puncture made in the manner already described. The first drop of blood is wiped away. The center of the cover-glass is allowed to touch the upper surface of the second drop of blood. The cover-glass, held in the manner already described, is now allowed to fall on the glass containing the drop of blood. If the operation is properly done and the drop of blood the right

size, the blood will spread out between the two cover-glasses and retain its circular shape. These two cover-glasses are then drawn or slid apart in a line parallel to the plane of their surfaces—never lifted apart—and two uniform smears result.

Instead of the cover-glasses a glass slide and a piece of stiff cigarette paper may be used. The technique is much the same. The cigarette paper is held between the thumb and middle finger on the under surface and the index finger on the upper surface, the latter forming a little gutter in the paper. The lower edge of the cigarette paper is dipped into and takes up a portion of the drop of blood. The paper is then straightened out on the glass slide and drawn along its upper surface. This will make a uniform smear if properly done.

Two glass slides may be used in a similar way to the method just described.

**Method of Fixation.**—Before any method of fixation is used the smear should be allowed to dry in the open air. If one of the Romanowsky stains is used no previous fixation is necessary, the fixation being done by the methyl alcohol employed as a solvent for the various stains.

1. Smears may be fixed by *heat*. After being air-dried they are exposed to a temperature of from 110° to 150° C. (230° to 300° F.); by placing the slides in a dry-air sterilizer, for about five minutes. Another method is to place the slides on a strip of copper which has been heated by a Bunsen burner to a maximum degree. In this case one-half hour is required for fixation. Fixation by heat is the best method, but the most difficult to use. It is the only reliable one if we wish to use Ehrlich's triple stain.

2. Smears may be fixed by placing them in a mixture of equal parts of *absolute alcohol and ether*, and allowing them to remain for from one-half to two hours; after fixation allow the fixative to evaporate or wash with water and dry (Nikiforoff's method).

3. Smears may be fixed in a 1 per cent. solution of *formaldehyde* in 95 per cent. alcohol. One minute suffices for fixation.

4. Finally, smears may be fixed by *absolute alcohol*, allowing from five min-

utes to one hour for fixation; the former time when an alcoholic stain is used, and the longer time for a watery or alkaline one.

*Methyl alcohol, C. P.*, fixes a smear in from three to five minutes. It is a great favorite and gives beautiful specimens. A longer fixation does no harm.

**Methods of Staining.**—Two varieties of stains are in use—the basic and the acid. Examples of the former are methylene blue, hematoxylin, basic fuchsin, methyl green, carmine, and toluidin. In these the staining property exists in the basic radicle of the salt. They include all the stains used for staining bacteria, and they all color the nuclei of cells. Examples of the acid stains are eosin, acid fuchsin, orange G, and picrate of potash. Here the staining property lies in the acid radicle of the salt.

**Eosin and Methylene-blue Stain.**—*Technique.*—The two stains are used separately. The smear is first fixed in pure methyl alcohol for three minutes, and is then immersed in a 0.5 per cent. alcoholic (70 per cent. alcohol) solution of Grüber's "french pure" eosin for from three to five minutes. The smear is then gently washed in distilled water, and dried between filter-paper.

The specimen is now placed in a well-mixed and carefully measured solution of 20 drops of a 0.0025 per cent. aqueous solution of methylene blue (B. pat.) and 10 drops of the above eosin solution for from one-half to one minute, then washed quickly with distilled water, and dried at once between filter-paper or over the flame (Müllern's method).

This method stains the erythrocytes a bright-red color. The nuclei of the different varieties of leucocytes are stained varying shades of blue, while the protoplasm is of a very pale blue color. The eosinophile and neutrophile granules are of a bright-pink to bright-red color, the neutrophiles being distinguished from the eosinophiles by their smaller size. The nuclei, mast-cell granules, bodies of the lymphocytes, blood-platelets, malarial organisms, trypanosomes, and filaria are of varying shades of blue.

**Eosin-hematoxylin Stain.**—This stain is specially adapted to specimens in which

we wish to study the nuclear structures. By its use the nuclei are beautifully stained, revealing details of structure, karyokinetic figures, and pycnotic qualities, as well as the basophile granules of both erythrocytes and leucocytes. The solutions required are a 0.5 per cent. solution of Grüber's blood eosin in 70 per cent. alcohol or a 0.5 per cent. solution of Grüber's "french pure" eosin in 70 per cent. alcohol, and *Delafield's hematoxylin solution*, which is composed of:—

Hematoxylin crystals	....	4 Gm.
Alcohol (absolute)	.....	25 c.c.
Ammonium alum crystals, C. P.	.....	52 Gm.
Distilled water	.....	400 c.c.
Glycerin, C. P.	.....	100 c.c.
Methyl alcohol, C. P.	...	100 c.c.

Triturate the hematoxylin crystals with the alcohol until they are dissolved and place the solution in a loosely corked bottle, allowing it to stand exposed to the light for four days. Dissolve the ammonium-alum in the water and allow it to stand exposed in the same way for four days. At the end of this time mix the two solutions, shake thoroughly, and filter at the end of three hours. Add the glycerin and methyl alcohol to the filtrate and allow this to stand overnight. Filter the mixture, place it in a clear bottle, and allow it to ripen, exposed to the light for six weeks, when it is ready for use.

**Technique.**—Stain the specimen with the eosin solution for one-half minute, and wash in water. Without drying place the slide in the hematoxylin solution for from one to three minutes, the time varying with the particular stain and with the experience of the worker. Wash with water, dry, and mount. This stain does not give as good results as the eosin-methylene-blue method, but is preferable for the study of nuclear structures (Webster).

**Wright's Stain.**—To a 0.5 per cent. solution of sodium bicarbonate in distilled water add 1 per cent. by weight of Grüber's medicinal methylene blue (any of the varieties of the dye may be used). Place the alkaline mixture in an Erlenmeyer flask and steam in an Arnold

sterilizer for one hour, counting from the time steam appears. This process develops the polychromatic powers of the alkaline solution of methylene blue and increases its value as a nuclear and granular stain. On cooling, the steamed solution is poured into a large evaporating dish and to it is added, with constant stirring, enough of a 0.1 per cent. aqueous solution of Grüber's yellow water-soluble eosin to change the color from blue to purple and to form a metallic luster on the surface. This will require about 500 c.c. of the eosin solution for every 100 c.c. of the methylene-blue solution. The resulting black granules contain the active principles of the stain. Collect the precipitate on a filter and allow it to dry, being careful not to wash it. When thoroughly dry make up a 0.3 per cent. solution of this precipitate in pure methyl alcohol. This will require some time and stirring of the mixture, as the precipitate does not dissolve easily. Filter the solution and add to the filtrate 25 per cent. of its volume of methyl alcohol to dilute the stain and lessen its tendency to become precipitated during the staining process.

**Technique.**—The air-dried films are covered with the stain for one minute; without washing off the stain add to it, drop by drop, water until the mixture becomes semitranslucent and a reddish tinge becomes visible at the edges of the slide or cover-glass; 8 or 10 drops of water will usually be enough. This diluted stain is then allowed to act for two to five minutes, after which it is washed off with distilled water, the blood-film now appearing of a deep blue or purple color. Immerse the slide, stained side downward, in a dish of distilled water, to develop the differential staining properties of the various elements by decolorizing the overstained specimen. This process is complete, as a rule, in from three to five minutes, but the experience of the worker, with any particular specimen, may suggest longer decolorization. The films will now appear reddish in color. When the desired degree of decolorization has occurred, dry the specimen quickly between filter-papers, mount if desired, and examine first with the low-power lens to

observe the staining effects, and then with the high-power lens for more minute study. When searching for malarial parasites, the decolorization would better be of short duration, as the chromatin suffers to a great extent in this process.

**Effects.**—The red cells colored by this stain are either orange or pink (depending on the time of decolorization), nuclei of leucocytes blue or dark lilac, neutrophile granules lilac, eosinophile granules red or pink, fine basophile granules deep blue, large mast-cell granules purple, protoplasm of the lymphocytes robin-egg blue, blood-plates deep blue or purple; bacteria, malarial and other parasites blue, the chromatin element varying from lilac to ruby-red and black. Polychromatophilia and granular degenerations are well shown, the granules being blue. This stain is much used in studying lymphocytes, mast cells, blood-plates, and the details of the malarial organism, but the granules of the leucocytes are not always sharply differentiated. Webster finds this stain well adapted for making a differential count, as it shows clearly the characteristics of the various types of leucocytes. Webster recommends this stain as a most serviceable one for routine work.

**Giemsa's Stain.**—Giemsa uses the pure staining substance extracted from the polychrome methylene blue, the methylene azure, making the stain a pure chromatin one. The formula is:—

Azure II .....	3.0 Gm.
Eosin, B. A. ....	0.8 Gm.
Glycerin, C. P. ....	250.0 c.c.
Methyl alcohol, C. P. .	250.0 c.c.

The dyes are dissolved in the alcohol by grinding, and the glycerin is then added. It is generally best to buy this stain ready prepared.

**Technique.**—The films are fixed in methyl alcohol, stained for five minutes in a mixture of 14 drops of the stain to 10 c.c. of distilled water, washed in water, dried, and mounted. The basic stain may be intensified by adding a trace of sodium carbonate to the distilled water first used. If the films are to be kept, the specimen should be stained on the slide, avoiding unnecessary mounting, for the reason that oil of cedar will bleach these

specimens rapidly. Avoid the action of strong light on these stained films for any length of time, as it causes rapid fading of the stain.

**Effects.**—These are similar to those of the Wright stain, except that the neutrophile granules are usually not so clearly brought out. For the study of the malarial organism and of smears kept long before being stained, this stain is especially good, as by its use the diffuse plasma staining does not occur.

**Ehrlich's Triple Stain.**—This stain is a mixture of methyl green, acid fuchsin, and orange G in alcohol, glycerin, and water. As it is difficult to prepare, it should be purchased ready made.

**Technique.**—The smear is fixed by heat, and a few drops of the stain placed upon it and allowed to remain for from one to ten minutes. It is then washed in distilled water, dried between filter-papers, and mounted.

**Effects.**—The erythrocytes are stained buff or orange, and the eosinophiles a crimson or bright red. The nuclei of the leucocytes take a dark-green stain, those of the normoblasts black, the neutrophile granules a lilac (occasionally of a reddish tinge). It is a poor nuclear stain, does not show the structure of normal mononuclear leucocytes, does not stain the basophile granules, nor the malarial or other parasites (Webster).

**Romanowsky's Polychrome Methylene-blue Stains.**—Romanowsky found that when aqueous solutions of eosin and methylene blue were mixed, an insoluble precipitate (methylene azure) was formed, which possessed new staining properties—the chromatin substance of malarial organisms was stained a beautiful red. In the preparation of these polychrome stains the pure methylene azure and eosin are not used, but solutions of methylene blue containing a variable amount of methylene azure to which eosin is then added. The Jenner, Leishman, Giemsa, and Wright stains are of this variety.

**Jenner's Stain.**—This is a methyl alcohol solution of the isolated precipitate (methyl azure or methylene-blue eosinate). It lacks the red chromatin staining element. This stain should be bought ready prepared.

**Technique.**—With this stain, fixation is unnecessary. The smear is dried, and a few drops of the stain are placed on it, and allowed to remain from one to three minutes, when it is washed off with distilled water. The smear is then dried and mounted.

**Effects.**—The erythrocytes and eosinophile granules are stained red, the nuclei blue, and the basophilic granules violet. Malarial organisms are stained blue. Emery suggests the use of this stain for the detection of bacteria.

**Leishman's Stain.**—This is a modified Romanowsky polychrome stain.

**Technique.**—Fixation is unnecessary. A few drops of the stain are allowed to fall on the smear and remain about two minutes; a couple of drops of distilled water are then added and left for two or three minutes longer. Then wash, dry, and mount the preparation.

**Effects.**—The erythrocytes are stained a pale pink and become slightly transparent. The protoplasm of the leucocytes is either colorless in the polynuclear variety, or pale blue in the mononuclear and lymphocytes, while the nuclei of the leucocytes have a ruby-red color. The eosinophiles are stained red.

This is one of the best stains to use when working with parasitic organisms. The nuclei of parasitic protozoa and malarial organisms are stained a bright red.

**EXAMINATION OF BLOOD-SMEARS.**—**Technique.**—The counting of blood-cells in fixed and stained blood-smears is easily and most satisfactorily done if there is a movable or a mechanical stage on the microscope. The slide is placed in position on the stage, the  $\frac{1}{8}$  or  $\frac{1}{4}$  inch lens used, and a field at one end of the smear located. The slide is moved from end to end across the stage of the microscope, a new field is then located, and the slide moved back again.

The different varieties of leucocytes are noted and a record kept as they appear one by one. At least 200 and preferably 500 leucocytes should be counted. After having counted the required number the total of each variety should be made and then the percentage of each may be easily calculated.

While counting the leucocytes the character, size, shape, and staining properties of the red cells should be observed. Any other contents of the specimen should also be noted.

**DIFFERENTIAL LEUCOCYTIC COUNT.**—By this we mean the counting of the different forms of the leucocytes in the stained smear, and the expression of the numbers found in terms of percentage. We note here the principal varieties of leucocytes.

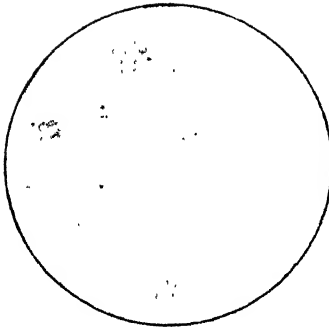
**Polynuclear Leucocytes.**—These are rather large cells and have an irregularly shaped nucleus. The protoplasm of the cell contains small granules to which the name neutrophile granules is often given. These granules are stained pink when Jenner's or the eosin and methylene-blue method is used, while they assume a coppery color when Ehrlich's method is used. In the normal blood 65 to 70 per cent. of the leucocytes are of this variety.

Under many diseased conditions these cells are increased in number, either relatively or absolutely. In sepsis there is a relative increase in the number of these cells, while the leucocyte count may be normal or diminished. This condition may also be present in malignant disease.

**Lymphocytes.**—These cells are rather small and contain a single, usually circular nucleus, which almost entirely fills the cell, there being only a narrow band of protoplasm around it. Both nucleus and protoplasm take the blue stain, but the former is more deeply stained than the latter. In normal blood these cells form from 24 to 28 per cent. of the leucocytes.

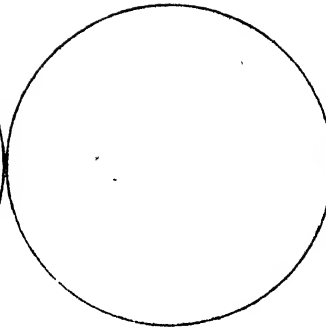
Under pathological conditions these cells may be increased (lymphocytosis) or diminished in number. In certain conditions, as pernicious anemia, splenic anemia, typhoid fever, and Hodgkin's disease, the cells are increased in number, while the total leucocyte count is either normal or lowered; while in infancy and many infantile diseases, they are increased, with a total high count.

**Large Mononuclear Leucocytes.**—These cells are much larger than the red blood-cells and contain a small nucleus, with a comparatively large amount of protoplasm surrounding it. Both nucleus and



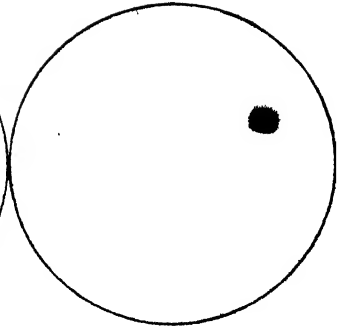
#### SECONDARY ANEMIA

Erythrocytes reduced in number, pale, owing to deficiency of hemoglobin. Crenated cells, often caused by evaporation of specimen. Poikilocytes: Pear- and bottle-shaped.



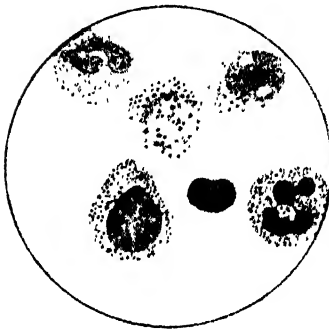
#### CHLOROSIS

Marked pallor of erythrocytes, owing to pronounced deficiency of hemoglobin. Poikilocytes when diseased. Blood platelets.



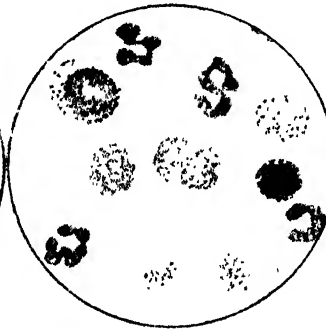
#### PERNICIOUS ANEMIA

Erythrocytes highly colored, some more so than others, owing to irregular distribution of hemoglobin and irregular in shape. Megaloblasts, megalocytes, and microcytes.



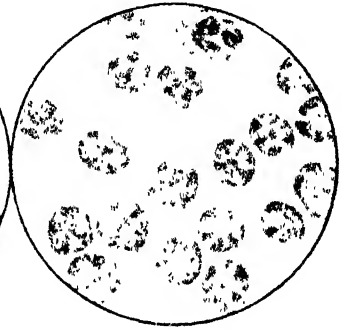
#### HODGKIN'S DISEASE

Advanced case, leucocytosis of various forms, but lymphocytes usually predominate. Low color index, owing to deficiency of hemoglobin.



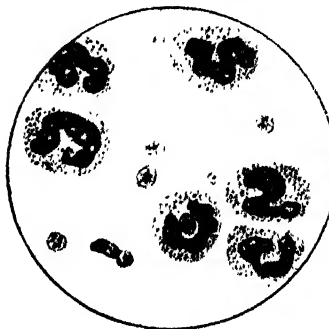
#### MYELOGENOUS LEUCOCYTHOSIS OR LEUKEMIA

Very high leucocytosis of all varieties, especially polymorphonuclears and eosinophiles. Basophilic myelocytes with granulations.



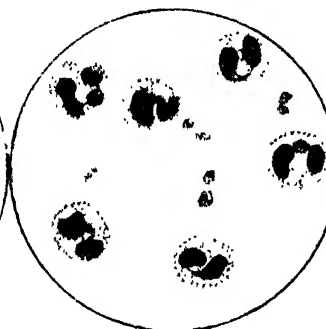
#### Lymphatic LEUCOCYTHOSIS OR LEUKEMIA

Leucocytosis, but mainly of lymphocytes larger than those of normal blood and probably immature. Secondary anemia also present, as a rule.



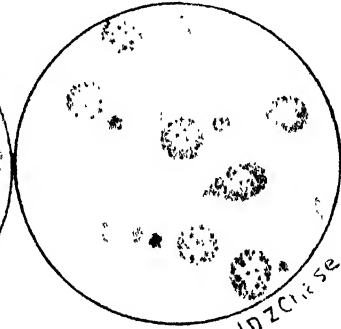
#### NEUTROPHIL LEUCOCYTOSIS

Marked relative increase of the polymorphonuclear cells, which are densely granular. Increase of blood-platelets.



#### EOSINOPHIL LEUCOCYTOSIS

Marked relative increase of eosinophiles somewhat smaller than the usual type. Increase of blood-platelets.



#### LEAD POISONING

Presence of granular erythrocytes, which vary in size and show polychromatophilia. Increase of blood platelets.

### BLOOD-PICTURE IN DIFFERENT DISEASES. (Salmons.)

Finer details of cells from Schlegel's Atlas, Rehman's Amer. Ed.





protoplasm take the blue stain, the former being deeply and the latter very faintly stained. Of the total leucocytes they form, in normal blood, from 1 to 4 per cent.

These cells may be increased or diminished in number under a few pathological conditions.

**Eosinophiles.**—These cells are about the same size as the polynuclear variety and have an irregularly shaped nucleus. The protoplasm contains many granules, which stain brightly with the eosin. They form, in normal blood, from 1 to 4 per cent. of all the leucocytes.

Under many diseased conditions there is an increase in the number of these cells and this is especially found in some of the parasitic diseases. In trichinosis the eosinophile count may be as high as 60, or even 80, per cent. Again, in ankylostomiasis there may be either a moderate or high eosinophilia. This is also the case in hydatid disease.

**Myelocytes.**—These cells do not circulate in the blood of healthy individuals, but may be found in the bone-marrow and are the mother-cells of the polynuclear leucocytes. Two varieties of these cells are found.

The one, **Cornil's myelocyte**, is a large cell which has a circular or irregular-shaped nucleus usually placed on one side of the cell, the latter having a small amount of protoplasm-containing neutrophile granules. These granules stain only faintly. The other variety, **Ehrlich's myelocyte**, is somewhat smaller than the first variety and contains a round or oval nucleus, which is usually located centrally, but may be to one side. The nucleus stains more deeply than that of the former variety, and the neutrophile granules are usually more distinct.

In myeloid leucocythemia both varieties of myelocytes are present in the blood and predominate over all other forms of leucocytes. Ehrlich's myelocytes may be found in the blood in certain of the infectious diseases, especially in diphtheria, and sometimes in anemia.

**Mast Cells.**—These cells average only about 0.1 per cent. of all leucocytes and are often altogether absent in the healthy individual. They resemble the poly-

nuclear leucocytes as to size. The nucleus takes up a large part of the cell and is irregular in shape. The protoplasm contains only a few granules, which stain blue with Jenner's stain.

These cells are very much increased, as much as 10 per cent., in myeloid leucocythemia, and are diagnostic of this disease when found in that number.

**LEUCOCYTOSIS.**—By this term is meant an increase in the number of white corpuscles. It is present under certain physiological conditions, as during pregnancy, after cold baths, and after a hearty meal. As a rule, the presence of over 10,000 leucocytes per c.mm. should be considered pathological, the normal variation being between 5000 and 9000 cells.

In leucocythemia there is an extremely high leucocytosis, in some cases the leucocyte count being as high as 1,000,000. A high leucocyte count is also found in suppuration, diphtheria, hemorrhage, and meningitis. A moderate leucocytosis occurs in inflammatory conditions where pus is not present, tonsillitis, rheumatism, secondary syphilis, malignant tumors, and in typhoid fever when perforation has occurred.

**LEUCOPENIA** means a diminution in the number of leucocytes, and the relative proportion of white cells in this condition is usually changed. Leucopenia occurs in intoxications, malaria, typhoid fever, influenza, and pernicious anemia.

**VARIATIONS OF VOLUME.**—These may occur both in the mass proper and in the fluid portion of the blood:—

**Oligemia** means a reduction in the total volume of blood, as regards both plasma and cells; **plethora**, an increase in the total volume of the blood, the opposite of oligemia; **hydremia**, an increase in the fluid portion of the blood, and **anhydremia**, a diminution in the liquid constituents of the blood.

**ERYTHROCYTES IN A STAINED SPECIMEN.**—Normal red cells stain pink and do not need to be described. They are normally non-nucleated, but under some pathological conditions they may contain nuclei, when they are called **normoblasts**, **microblasts**, or **macroblasts** or **megaloblasts**, according to their size. Non-nucleated erythrocytes which are

normal in size are called **normocytes**; when larger than normal, **macrocytes** or **megalocytes**, and, when smaller than normal, **microcytes**.

**Microcytes** are decidedly small, non-nucleated cells which may be found in any severe anemia.

The **poikilocyte** is another form of non-nucleated red cell. This is an irregularly shaped red cell which may be of any size. This variety of red corpuscle is most commonly found in cases of pernicious anemia.

In any severe anemia, but especially in pernicious anemia, red cells are sometimes found which take the basic as well as the acid stain. These cells, therefore, are found to be stained with the different colors. **Polychromatophilic degeneration** or **polychromasia** is the term applied when this condition is present.

Another condition of the red corpuscles found in some of the severe anemias, but particularly von Jaksch's anemia of infants, is **granular degeneration**. Here the red cells contain many granules which are stained deeply by the basic stains.

**Normoblasts** are nucleated red corpuscles of normal size. They are normally present in the blood at and for a short time after birth, but later in life are found only in the bone-marrow, except under pathological conditions. The nucleus is found in the central part of the cell and is very large. It stains very deeply and there is only a narrow band of protoplasm surrounding it.

These cells are found in the blood in cases of anemia and are rather a good sign, showing that the bone-marrow is so active that some of the cells are extruded and enter the blood.

The **megaloblasts** are nucleated red cells which are very much larger than normal. The nucleus is small in proportion to the size of the cell and does not stain so deeply as that of the normoblast. When present in any number in the blood of adults these cells are almost diagnostic of pernicious anemia. They may also be found in the anemias of infancy.

**BLOOD-PICTURE IN DIFFERENT DISEASES.—Pernicious Anemia.**—The first striking characteristic of the blood noted in this disease is the high color-

index (usually over 1). It increases in proportion to the diminution in the number of red corpuscles. There is a leucopenia present, the leucocytes rarely being above 6000. The differential blood-count shows a relative lymphocytosis usually, the lymphocytes rarely being below 40 per cent. Megalocytes, megaloblasts, and normoblasts are usually present, and late in the disease poikilocytosis, polychromatophilic and granular degeneration may also be found.

**Chlorosis.**—In this condition the color-index is low (average is 0.5; may be lower); there is a reduction in the number of red corpuscles and a great reduction in the percentage of hemoglobin, causing the corpuscles to be very pale. The white corpuscles are usually normal in number, but there may be a leucopenia.

**Secondary Anemia.**—Here again the color-index is diminished, but not to such a great extent as in the previous disease. It rarely falls below 0.7. Both the number of red corpuscles and the percentage of hemoglobin are reduced, but there is usually a slight leucocytosis, the polynuclear leucocytes, especially, being increased. All those conditions which cause anemia and have a known cause are included under this heading.

**Myelogenous Leucocythemia ("splenomedullary").**—In this condition there is a very high leucocytosis, the white corpuscles in average cases reaching 400,000. All varieties of leucocytes are increased, but especially the polynuclear and eosinophile varieties. Both Cornil's and Ehrlich's myelocytes, large cells with basophilic granulations, and eosinophilic myelocytes are also present. There are many normoblasts present and usually anemia of a secondary type.

**Lymphatic Leucocythemia.**—Here again there is an enormous leucocytosis (100,000 to 1,000,000) especially affecting the lymphocytes, which may reach 99 per cent. There is also an anemia of the secondary type present.

**Hodgkin's Disease.**—This disease is very difficult to diagnose from the blood-picture alone, as in a true case of the disease there is no change in the blood-picture until late, when there is a slight leucocytosis with anemia of a secondary

type. In some cases the blood-picture may simulate that of lymphatic leucocythemia.

**Splenic Anemia.**—There is an anemia in this condition with a leucopenia usually. The color-index rarely falls below 0.7. Normoblasts, poikilocytosis, and polychromasia may be found. There is usually a marked increase of polymorphonuclears and a relative increase of all other forms of leucocytes, especially lymphocytes.

**Infantile Anemia, Pseudoleukemia, or von Jaksch's Anemia.**—Here a high leucocytosis and an extreme anemia are present. The color-index is usually low. All kinds of abnormal red cells may be found, normoblasts usually being quite numerous.

**Secondary anemia in infants,** such as occurs in rickets, scurvy, tubercle, and syphilis, shows a low color-index and, usually, a leucocytosis with a lymphocytosis. Normoblasts and, sometimes, megaloblasts may be found.

**Septicemia.**—The hemoglobin and red corpuscles are particularly involved in this condition. There is a reduction in both. The severer the case, the more rapidly the hemoglobin falls.

A diagnosis of septic infection after parturition can be made if a blood-count, made within a few days, shows a red blood-count below 4,000,000, providing there has not been any abnormal post-partum bleeding. A slight leucocytosis affecting the polynuclear cells may also be present.

**Suppuration** shows a high leucocyte count, varying between 15,000 and 25,000, the polynuclear cells usually being the ones increased. A valuable confirmatory test is the glycogen reaction, which is usually present (Emery).

**Typhoid Fever.**—There is a slight increase in the erythrocytes early in this disease, but, later, these cells are decreased in number. There is usually a normal or diminished leucocyte count and often a moderate lymphocytosis.

Should hemorrhage occur, there may be a fall in the number of red cells and a slight leucocytosis; but there is a rapid increase in the number of leucocytes (15,000 or more) if perforation occurs.

**Pneumonia.**—There is a moderate anemia of the secondary type in this disease and a marked leucocytosis proportionate to the extent of the lesion, the polynuclear cells being especially involved (may reach 95 per cent.). In some few cases of pneumonia there may not be a leucocytosis.

At the crisis the leucocytes usually fall to normal, but should the leucocyte count remain high after the crisis it is indicative of empyema.

**Malaria.**—In this condition there is an increase of the large lymphocytes, although the leucocyte count remains normal. Anemia is usually present. The blood should, of course, be examined for the specific micro-organism.

In **scarlet fever** and **whooping-cough** there is a leucocytosis, higher (20,000 to 60,000) in the latter than in the former (10,000 to 40,000) disease. The polynuclear cells are increased (80 to 90 per cent.) in the former disease, while there is a lymphocytosis in the latter.

In **influenza** and **measles** there is no leucocytosis if complications do not occur, while **rheumatism** shows a leucocytosis which if over 20,000 denotes the presence of some complication (endocarditis, pericarditis, pneumonia, etc.).

**Tuberculosis** shows a secondary anemia with a normal leucocyte count usually, although there may be a marked increase in the lymphocytes.

**Syphilis.**—This disease shows an anemia of the secondary type. There is a moderate increase in the number of white corpuscles (12,000 to 16,000) due to a lymphocytosis.

**Purpura Hemorrhagica.**—Here again there is an anemia with the color-index either normal or low. There is usually a leucocytosis due to an increase in the polynuclear cells, although there may be a leucopenia present with an increase in the lymphocytes.

**Carcinoma of the Stomach.**—In this condition the blood-picture may show an anemia of the secondary type, a low color-index (average 0.63), and a slight leucocytosis (12,000 to 18,000) due mainly to an increase of the polynuclear variety (80 to 90 per cent.), or the color-index may be high and megaloblasts and megacocytes may be present.

**Malignant tumors** usually show a moderate polynuclear leucocytosis with slight anemia.

In **ulcer of the stomach, alcoholic cirrhosis of the liver, and hydatid cyst** a secondary anemia is usually present, but without a leucocytosis. In **Hanot's cirrhosis and abscess of the liver** leucocytosis is present. In **hydatid cyst** there is usually an eosinophilia.

**Pleurisy with empyema, bronchitis, and bronchopneumonia** show a moderate or high leucocyte count (18,000 or more).

**Asthma** shows a moderate leucocytosis and an eosinophilia, the latter being excessive (average 10 per cent.) during the attacks and moderate between them. The mast cells are said to be increased.

**Valvular Lesions.**—There may occur an increase in the red corpuscles (up to 8,000,000) in mitral disease, and an anemia in the case of aortic disease, the leucocytes being normal in both conditions.

**Non-suppurative inflammations of the uterus** show a moderate leucocytosis, while **suppurative cases** shows a marked increase in the leucocytes; 18,000 usually indicate the presence of pus.

Leucocytosis may or may not be present in cases of **pyosalpinx**, according to the cause.

Certain skin diseases, as **erythema multiforme, dermatitis herpetiformis, and pemphigus**, show an eosinophilia, sometimes as high as 10 per cent. A moderate or high leucocytosis may also exist.

**ARNETH'S CLASSIFICATION OF THE LEUCOCYTES.**—The neutrophilic leucocytes are grouped by Arneth into 5 classes according to the number of lobes their nuclei exhibit, *viz.*, 1 (round or indented), 2, 3, 4, and 5 or more. The average normal percentages of these 5 classes are, respectively, 5, 35, 41, 17, and 2 per cent. Under abnormal conditions, an increase of the lower classes of cells at the expense of the higher sometimes occurs, and is known as a "shift of the neutrophilic blood picture to the left." The "Arneth index" is obtained by adding the percentages of the first, second, and half of the third classes. Briggs found this index to be between 51 and 65 in normal persons. In pernicious anemia it was low (16.5 to 51.25), and proved of diagnostic utility for

the differentiation of this disorder from severe secondary anemias. A "shift to the left" occurs regularly in tuberculous, pyogenic, typhoid, and malarial infections, and in the first-named infection, the variations to and from the normal formula have been considered of prognostic significance.

**RESISTING POWER OF THE ERYTHROCYTES.**—As is well known, the resisting power of the red cells to hypotonic solutions is decreased in hemolytic jaundice and increased in pernicious anemia. As described by Martinet, the resisting power is determined as follows: Serial mixtures of sterile 0.9 per cent. NaCl solution and sterile distilled water are prepared in 18 small, sterile test tubes. In the 1st tube are placed 18 drops of salt solution and 0 drops of distilled water; in the 2d tube, 17 drops of salt solution and 1 of water, and so on to the 18th tube, which contains 1 drop of salt solution and 17 of water. The 1st tube is labelled 9; the 2d, 8.5; the 3d, 8, and so on to the 18th, which is labelled 0.5. In making the test, 1 drop of the patient's blood is dropped into each tube, and the tube at once shaken. After allowing 1 hour for the corpuscles to settle, the tubes are examined. The 1st few tubes show a colorless fluid, no hemolysis having occurred in them. The 1st tube showing a yellow color is that of "initial hemolysis," and the 1st in which there is no sediment at the bottom is that of "complete hemolysis." Normally, initial hemolysis occurs at 0.44 to 0.48 (*i.e.*, in the tubes labelled 4.5 or 5) and complete hemolysis at 0.32 (in the tube labelled 3).

According to Acél and Spitzer (Deut. med. Woch., Aug. 15, 1924), the resistance is increased about 35 minutes after a test meal in normal persons and those with gastric hyperacidity; increase of the carbon dioxide tension of the alveolar air occurs simultaneously. *In vitro*, a little sodium bicarbonate solution added to the blood was observed likewise to augment red cell resistance.

**BLOOD SEDIMENTATION TEST.**—That acute inflammations were attended with an increased rate of blood sedimentation was brought out as long ago as the close of the 18th century by John Hunter. In 1916, Fahraeus called attention to the presence of this phenomenon in pregnancy, and since

then numerous additional studies of it have been recorded.

The diagnostic value of sedimentation tests has been stressed, among others, by M. E. Alexander (Med. Jour. and Rec., June 4, 1924), who employed *Linzenmeier's technic*. Small test tubes of 5-mm. ( $\frac{1}{2}$  inch) caliber are marked at 1 c.c. and also 18 mm. below this mark. Sodium citrate, 0.2 c.c. of a 5 per cent. solution, is first put in each tube and blood added to the 1 c.c. mark, to be followed by gentle shaking or stirring. Accelerated rate of sedimentation consists of settling of the red cells to the 18 mm. level in less than 1 hour (at room temperature). Addition of bile, even in very small amounts, seems greatly to delay sedimentation. In 40 cases of *pregnancy*, an increasing acceleration of sedimentation was observed after the 3d month, the average being 20 minutes and the range, 6 to 40 minutes. In 22 cases of *active pulmonary tuberculosis*, the rate was greatly accelerated (15 to 45 minutes), while in 12 healed or completely arrested cases it was normal (90 to 120 minutes); likewise in some cases of early renal tuberculosis and cervical adenitis. In 29 cases of *acute inflammation* (acute arthritis, erysipelas, lobar pneumonia, tonsillitis) there was marked acceleration. In 25 cases of *chronic arthritis* there was acceleration in 8; these 8 had acute exacerbations some days or weeks later, while the other 17 cases did not have any. The rate was extraordinarily accelerated during the exacerbations, though the temperature and leukocytes were but very slightly elevated. In 20 cases of *late syphilis*, the rate was increased. In 2 paretics the red cells settled in 6 minutes.

The test is of paramount value in differentiating *inflammation of the pelvic organs* (sometimes unattended with fever or pulse acceleration) from tumors or cysts in the same region. It has been found serviceable in deciding the time for operation in *gonorrheal salpingitis*, in which it reveals the time when acute inflammation has subsided. In *pregnancy* it is of definite value in the 4th, 5th or even later months, when it becomes necessary to differentiate the condition from uterine myomas or cysts.

The test has been deemed of some value in the diagnosis of *unruptured ectopic pregnancy* by B. Friedlaender (Amer. Jour. of

Obst. and Gyn., Feb., 1924). Ruptured ectopic pregnancy, having about the same sedimentation time as pelvic inflammatory conditions, must be diagnosed by exclusion. A sedimentation time under 30 minutes means *active infection*, and under 1 hour, *latent infection*, contraindicating operation. A time over 2 hours excludes all possibility of a latent or active infection. No dilatation, curettage or other surgical procedure should be undertaken without doing a sedimentation test to exclude latent infection.

Accelerated sedimentation occurs also in *anemia* and in disorders attended with increased absorption of katabolic products, viz., *inflammatory processes, wounds, fractures, aseptic operations, and malignant tumors*. It assists in distinguishing *bone tuberculosis* from osteochondritis, Perthes's disease and loose bodies in the joints. *Esophageal cancer* may be distinguished from cardiospasm or diverticulum, and *cholelithiasis* possibly from duodenal ulcer. In *syphilis* it is positive earlier and longer than the Wassermann. In *convalescence* in general it is a serviceable guide, subsiding much more gradually than the temperature and leukocytosis (E. Rothe).

The prognostic value of the test in *pulmonary tuberculosis* has been emphasized by Bochner and Wassing (Jour. Lab. and Clin. Med., Dec., 1925). In many other conditions it has also proved its value. Its adoption is justified as an added check to the leukocyte count, temperature and subjective and objective findings, and in the diagnosis and prognosis of acute and chronic inflammatory conditions.

In performing the test, Bronnikoff employs the tube from Sahli's hemoglobinometer outfit and reads off the depth of the column of blood plasma every  $\frac{1}{2}$  hour.

**BLOOD PLATELETS.**—The platelets are small, rounded or rod-like bodies, averaging 3 microns in diameter, usually homogeneous, and staining lightly with both acid and basic dyes. They contain no nucleus and tend to clump together in shed blood. The normal range of the number of platelets per cubic millimeter of blood was found by Thomsen to be from 206,700 to 413,400. In infancy, Keilmann found 48,000 to 192,000.

A simplified modification of the *Thomsen method of platelet enumeration* which makes

it available for all practitioners has been described by Gram. In a Sahli glass (graduated tube of the Sahli hemoglobinometer) 3 per cent. sodium citrate solution is poured up to the mark 10 and venous blood then run down a curved needle into the citrate solution to the mark 100. After shaking and allowing to stand for an hour, a little of the citrated plasma is withdrawn with a pipette and diluted 1:20 with normal saline solution and a few drops of formaldehyde solution per 100 c.c. Counting the platelets in 5 large squares of the Thoma-Zeiss counting chamber, after waiting  $\frac{1}{2}$  hour, yields the number of thousands of platelets per cu. mm. of the citrated plasma. The proper figure for the whole blood is obtained by multiplying the result by a constant, which varies according to the percentage of hemoglobin in the particular specimen of blood, viz., 0.63 for 100 per cent.; 0.68 for 90; 0.73 for 80; 0.78 for 70; 0.82 for 60, etc.

Another method, that of Wright and Kinnicutt, consists in diluting the blood 1:100 with the ordinary hemacytometer pipette, the diluting fluid being a fresh mixture of 2 parts of a 1:300 solution of brilliant cresyl blue and 3 parts of a 1:400 solution of potassium cyanide. The Thoma-Zeiss counting chamber is then filled with the diluted blood, 10 to 15 minutes allowed to elapse in order that the platelets may settle and the count then made. The platelets appear as sharply outlined, rounded, lilac-colored bodies. The red cells have been decolorized, appearing only as shadows.

Marked variations in the platelet count occur in certain morbid states. In acute infections they are subnormal or normal until the crisis, when a sudden, pronounced increase occurs. In secondary anemia they are usually increased, but, in pernicious anemia always greatly decreased. In the leukemias, they are increased in the myelogenous form, decreased in the chronic lymphatic form. In tuberculosis they are somewhat increased; in purpura hemorrhagica, reduced to an extreme degree. Platelets are usually 2 to 4 microns in diameter, occasionally larger. They are generally considered to bear some relationship to blood coagulation. According to Sajous, they consist of oxygen-laden adrenal secretion, extruded from the erythrocytes.

**VISCOSITY OF THE BLOOD.**—Viscosity, i.e., viscosity, is one of the 2 main factors upon which the degree of peripheral resistance to blood circulation depends, the other factor being the caliber of the arterioles and capillaries. With the viscosity of distilled water considered as 1, the normal blood viscosity in adults is between 4.5 and 5.1. In infants it is placed at 3.2 to 3.6, increasing thereafter up to adult age. According to Sachs, variations beyond the range of 4.4 to 5.3 in men and 3.9 to 4.9 in women should be considered abnormal.

For the clinical determination of the blood viscosity a number of different forms of apparatus have been used. Among the best known are the Hess and the McCaskey viscosimeters. The method of Denning and Watson, however, which is similar to that of Cuvier, of Bordeaux, is simpler, and renders viscosity determinations a clinically available procedure, consuming but little time. The instrument is a J-shaped glass capillary tube about  $2\frac{1}{2}$  inches long, with a small funnel-shaped flare at the upper end of the long arm and an elliptical bulb-like expansion of the capillary tube in the short arm. In using it, a drop of blood is placed in the receiving funnel, and passes down the capillary tube. The exact times of entrance and completed filling of the bulb are taken with a stop-watch, and the ratio of the time elapsed to that obtained in similar tests with distilled water gives the viscosity of the blood under examination. Direct testing of the blood as it exudes from the ear lobe or finger tip obviates difficulty from clothing, and the instrument should be washed out immediately after use, for the same reason. As temperature variations cause distinct discrepancies in the readings, it is recommended that the instrument be always warmed to body temperature before use.

Some of the factors influencing viscosity are as follows: Water and food in large amount temporarily reduce it. Carbon dioxide in the blood markedly increases it, up to 8 and even 12 in asphyxial states. Intravenous saline infusion reduces it temporarily, hemorrhage more persistently. The therapeutic value of venesection is believed to lie at least partly in the resulting reduction of viscosity. In cardiovascular disease, slight exertion markedly augments

viscosity, and according to some, increased viscosity is an early indication of heart inadequacy, and the degree of viscosity of prognostic value. It is lowered in primary and secondary anemias and usually in leukemia, malaria, and typhoid fever. It is increased in polycythemia, in jaundice, in diabetes mellitus, and usually in pneumonia and emphysema. Especial importance has been attached to the viscosity in interstitial nephritis, in which it is low even though the blood-pressure be high.

Following injection of foreign proteins, in infectious diseases, and after surgical operations, W. and H. Löhr found a marked increase in the viscosity of the blood plasma, together with an increased rate of sedimentation, diminished surface tension and increase of fibrinogen. High sedimentation rate and viscosity invariably went hand in hand, among other instances in cases with marked protein decomposition.

**BLOOD CHEMISTRY.—NITROGENOUS COMPOUNDS.**—The percentage composition of the nitrogenous non-protein content of the blood is under normal conditions, approximately as follows: Urea nitrogen, 50 per cent.; uric acid, 2; creatinin, 2; ammonia nitrogen, 0.3; and undetermined, 46. (In the urine, the corresponding percentages are: 85, 1.5, 5, 4, and 4.) The kidneys remove ammonium salts and creatinin from the blood almost completely. Uric acid, however, is excreted with difficulty, while urea holds an intermediate position. In renal insufficiency, therefore, there is retention first of uric acid, then of urea, and lastly of creatinin. In malignancy, pneumonia, intestinal obstruction, and some cases of acute nephritis, urea retention may be very high. In gastric and duodenal ulcer there is often slight urea retention. In eclampsia the blood urea is only very slightly elevated, if at all. In advanced nephritis, urea estimation is of less prognostic value than creatinin estimation, but is a better guide to the value of treatment. In prostatic obstruction, urea estimation is of great prognostic importance.

According to Folin, the total nitrogen normally ranges from 24 to 32 milligrams per 100 c.c. of blood. The urea was found by Schultz to range from 10 to 23 mgm.; the uric acid averaged 2 to 3 mgm., and the creatinin, 1.1 to 1.3 mgm. Similar figures

were obtained by Schultz in infants and children, the uric acid ranging, however, from 0.55 to 4.75 mgm.—a wide variability likewise common in the blood of adults.

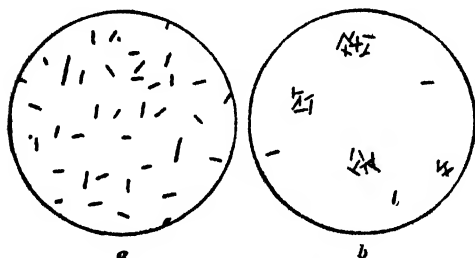
**Blood Urea Determination.**—The *Van Slyke and Cullen* method, a modification of the Marshall procedure, is as follows: Into a large, 100-c.c. test-tube are placed 1 c.c. of 3 per cent. sodium citrate solution and 3 c.c. (accurately measured) of the freshly drawn blood. After shaking, 0.5 c.c. of urease solution and a few drops of amyl alcohol are added. After the tube has been set aside for ten or fifteen minutes, 15 c.c. of saturated potassium carbonate are introduced and the resulting ammonia drawn off by a suction apparatus through another 100-c.c. tube containing 15 c.c. of  $\frac{1}{100}$  normal hydrochloric acid. After waiting fifteen or twenty minutes more for the absorption of the ammonia, the remaining acid is titrated with  $\frac{1}{100}$  normal sodium hydroxide solution, methyl red or alizarin being used as indicator. From the number of c.c. of acid thus shown to have been neutralized by the ammonia set free from the blood, the amount of urea in the blood is calculated. Every c.c. of acid neutralized represents 0.01 Gm. of urea per 100 c.c. of blood.

**Total Nitrogen and Non-Protein Nitrogen Determinations.**—The methods introduced by *Folin* and his co-workers are generally employed in these determinations. In determining the *total nitrogen*, 1 c.c. of blood from a vein is diluted with distilled water up to 25 c.c., and 1 c.c. of the resulting dilution used in the further steps of the determination. For the *non-protein nitrogen*, 2 c.c. of blood are placed in a 25-c.c. flask already containing 20 c.c. of pure methyl alcohol, enough of the alcohol added to make 25 c.c., and after shaking, the mixture stood aside for two or three hours. It is then filtered, 3 drops of saturated alcoholic zinc chloride solution added, and filtered again. From the clear, colorless solution thus obtained the total or the non-protein nitrogen content is estimated by another series of procedures for the details of which the reader is referred to special works on clinical analysis. In brief, the nitrogen content of the solution is oxidized with a sulphuric acid mixture, and the ammonia formed set free by ad-



dition of alkali and carried over into an acid solution by a current of air. The solution is then treated with Nessler-Winkler solution (mercuric iodide, potassium iodide, and sodium hydroxide) and the color thus obtained compared with a standard solution of an ammonium salt similarly dealt with.

A distinct increase in the non-protein or incoagulable nitrogen of the blood has been found to occur after large protein meals. It is believed that a similar rise may take place in abnormal states associated with increased protein catabolism, *c.g.*, in fevers and certain intoxications. To avoid discrepancies in results on account of such outside factors, it has been found necessary in estimating the renal function to place patients on a standard diet and



Stages in Widal reaction. *a*, negative reaction; *b*, positive reaction. (Robin.)

make the chemical determinations at definite times of the day.

**Uric Acid.**—This is believed to exist in the blood almost entirely in the form of monosodium urate. In gout, the increase in uric acid is generally unassociated with any pronounced increase in non-protein nitrogen, while in nephritis, increase in the latter component may not be accompanied by any notable increase of uric acid. In advanced uremia, however, both are likely to be enormously increased. Folin and Denis found an average of 4.3 mgm. of uric acid per 100 c.c. in 12 cases of gout, and one of 8.4 mgm. in 4 cases of uremia.

**CHLORIDES.**—The chloride content of the blood may undergo considerable variations, but the deviations from the normal are very promptly made up through readjustments with the tissue fluids, so that determination of the chlorides in the blood is of but slight service in the clinical study of chloride elimination. More valuable for

determining the permeability of the kidneys to salt in nephritic cases are alimentary chloriduria tests and determination of the chloride balance, *i.e.*, comparison of the intake and output of chlorides. According to Castaigne, the normal chloride content of the blood is 0.67 per cent. Marked and persistent impermeability of the kidneys must occur, he states, before a notable increase will be shown. Scheer, in resting infants, noted a chloride content of the blood serum of 0.50 to 0.59 per cent. Secretion of gastric juice for the digestion of food caused it to decline rapidly, but it rose again when the stomach was emptied. It may drop very low in pneumonia and in severe vomiting.

**CHOLESTEROL.**—Normal blood contains about 0.15 per cent. of cholesterol (cholesterin). A diet poor in lipoids and fever are factors lowering this percentage. Conversely, the cholesterol is increased by a diet rich in lipoids; by certain diseased conditions, such as diabetes, arteriosclerosis, and nephritis; by pregnancy, and by complete obstruction of the common bile duct. According to Hewes, the blood lipoids play a rôle analogous to an antitoxin, and are intimately associated in immunologic processes. They are known to counteract certain poisonous substances.

In cholesterol determination by the *method of Myers*, 1 c.c. of blood plasma or serum is stirred with 4 or 5 Gm. of plaster-of-Paris, dried in a drying oven for an hour, and extracted with 20 c.c. of chloroform for 1½ hour in a somewhat special apparatus with reflex condenser. The amount is then brought up to 20 c.c. again by addition of chloroform, and the preparation filtered. Five c.c. of the extract are placed in a test-tube and 2 c.c. of acetic anhydride and 0.1 c.c. of concentrated sulphuric acid added. After mixing, the solution is placed in the dark for exactly ten minutes to permit coloration to develop, and is then compared with a standardized 0.005 per cent. solution of naphthol green-B in a Kober or Duboscq colorimeter.

**SUGAR.**—See under **DIABETES MELLITUS**, **OPSONINS AND OPSONIC INDEX.**—Sir A. Wright has demonstrated the presence in the blood of substances which he calls opsonins, and which have the power of acting on pathogenic bacteria.

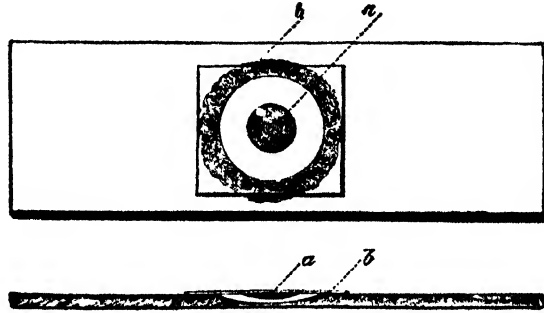
and so altering them that they can be taken up and digested by the leucocytes. These substances appear to be the chief agents in the production of some forms of immunity.

The method given by Wright is a general one, available for any organism, the only points of difference lying in the preparation of the emulsion of bacteria, which differs slightly with the various organisms. The process is not an easy one, and considerable patience and some practice are required for its mastery. See also under BACTERIAL VACCINES, Vol. II.

**SERUM REACTIONS.**—The **Widal Test**.—This blood test, used for the diagnosis of typhoid fever, depends upon the

salt solution; 1 drop of this dilution is then mixed with 1 drop of bacterial culture.

**Technique.**—The test is most often made from specimens of dried blood, a few drops of the latter being allowed to fall on glazed paper and dry. Exact dilution in this case is impossible, but if we dissolve the clot in an equal quantity of distilled water and mix 1 part of the solution with 20 parts of the culture by means of a capillary tube, practically accurate results may be arrived at. For mixing, in this case, we may use the mixing pipette of the hemocytometer, expelling the fluid carefully on a cover-glass for a hanging-drop preparation. (Incidentally, we may explain that a hanging-drop preparation is



Hanging-drop preparation. (Crockshank.)

action of bactericidal substances developed in the blood of typhoid patients on cultures of *Bacillus typhosus*. If we add 1 part of typhoid blood-serum to 10 parts of a twenty-four hour broth culture of *Bacillus typhosus*, the bacteria become motionless and separate from the fluid in clumps. This reaction may be seen in a hanging-drop preparation of the culture to which a drop of dissolved blood is added from a platinum loop. The motility of the bacilli is rapidly lost and they become clumped in characteristic masses.

Since, however, it is possible for normal agglutinins to be active, in the absence of typhoid infection, in dilutions as high as 1:20, such a dilution is regarded as the minimum for practical purposes, and commonly 2 slides with dilutions of 1:40 and 1:80 or 1:50 and 1:100 are employed. Thus, for a 1:40 dilution 1 drop of the serum is diluted with 19 drops of normal

made as follows: A drop of the mixed fluids is placed on a clean, dry cover-glass and a hollow-ground slide with a ring of oil painted around the well is laid on the cover-glass and pressed down so that the oil around the well adheres to the cover-glass; if the slide be now inverted, the hanging-drop preparation is made; it will not dry if the seal made by the oil is perfect.)

The slides are placed in a dark place and examined microscopically an hour later. Clumping and general loss of motility (though a few separate motile germs may still be visible) mean a positive reaction: Where there is only a partial loss of motility and a few indefinite clumps are seen, the result is doubtful. The time for examination may be shortened to  $\frac{1}{2}$  hour by using 1:20 and 1:40 dilutions, but as already mentioned, unduly low dilutions reduce the reliability of the test. Similar tests may be performed with the paratyphoid organisms.

*Occurrence of the Reaction.*—The test is positive in typhoid fever: In 70 per cent. of cases from the fourth to the seventh day; in 80 per cent. of the cases from the eighth to the fourteenth day; in 90 per cent. during the third and fourth weeks. In from 5 to 10 per cent. of the cases it is absent throughout. The reaction persists in the blood for months, or even years, but after three or four months it is usually feeble.

**The Wassermann Reaction.**—This is a useful blood-test for syphilis which is applicable relatively early in the disease. The theory of the reaction is rather complicated, and for its comprehension an understanding of hemolysis and immunity is essential.

*Hemolysis.*—This term means the decolorization and dissolution of blood-cells, and particularly of the red corpuscles. If the latter are mixed with normal saline, or other inert, solution they, the red cells, will gradually fall to the bottom of the vessel, forming a red deposit, leaving above a clear, colorless fluid. If, however, certain other substances are present the cells will become decolorized by losing their hemoglobin, which will impart a red color to the fluid. There will be practically no deposit, as the stroma of the cells is quite invisible. Of the many substances (hemolysins) that will cause this hemolysis we will here only consider those of the blood-serum. As a rule, the normal serum of one animal will not hemolyze the red cells of another species, but it can acquire hemolytic properties upon injection of the animal with red cells from an animal of the second species. The serum of a normal rabbit will not hemolyze human red corpuscles, but if the rabbit is injected with 2 or 3 doses of human red corpuscles a few days apart, the serum of the rabbit will be found to hemolyze the human red cells when mixed with them and incubated at body heat. The serum of a rabbit injected with sheep corpuscles will hemolyze the sheep's corpuscles, but will have no effect on human corpuscles.

This hemolytic power is due to two substances, one of which is always present in normal serum, the other being produced by the injection. The former is called *complement*. Though it is present

in all serum, it varies in amounts and is easily destroyed by heat (130° F. for half an hour, or 140° F. for ten minutes), and it vanishes in a few days at room temperature, in its behavior to heat resembling the enzymes. The second is called *amboceptor*. This, as may be inferred, is rarely present in normal serum, but is produced by the injection of alien cells. It is not easily destroyed. Heat that would efface every trace of complement has no effect on amboceptor, and at room temperature it will remain in serum for months. Hemolysis depends on the presence of *both* substances. No hemolysis will occur if either is absent. The union of the three elements (corpuscle, amboceptor, and complement) forms a *hemolytic system*, which at body temperature goes into solution. If we wish to ascertain the presence of complement in any fluid (serum, normal saline, etc.), we have merely to add corpuscles that have been saturated with amboceptor; if hemolysis occurs it demonstrates the presence of complement in the fluid.

*Blood-corpuscle Emulsion.*—To prepare this make a saline solution containing 0.9 per cent. salt and about 2 or 3 per cent. sodium citrate. Drop a small amount (10 to 20 drops) of blood from a finger puncture into 10 c.c. of the saline solution and centrifuge until the corpuscles are deposited and the fluid clear. Pour off the fluid and replace it with ordinary normal saline; mix thoroughly and centrifuge again; repeat the process once more. The corpuscles will now be washed free of serum. With a pipette take 19 units of saline solution and 1 unit of the washed corpuscles and mix them thoroughly. This will make a 5 per cent. emulsion of corpuscles ready for use.

*Absorption of Complement.*—If a little serum from a syphilitic containing complement is mixed with certain emulsions of fatty substances and then incubated the complement will be absorbed or disappear. This disappearance does not occur if serum from a non-syphilitic is used. One element of the hemolytic system having thus been lost, no hemolysis can occur when amboceptor is added and the mixture incubated, such absence of hemolysis is recorded as a positive reaction. To be certain that complement was present in the

syphilitic serum before the addition of the fatty emulsion, the serum should receive a preliminary test with amboceptor; the occurrence of hemolysis would denote its presence.

*Antigen.*—The emulsion of fatty substances is called *antigen* and may be prepared in several ways. An alcoholic extract of fetal syphilitic liver known to contain numerous spirochetes (Levaditi staining method) is preferred. As described by Kolmer, 10 Gm. of such liver are minced, ground with quartz sand, and treated with 100 c.c. of absolute alcohol. The mixture is shaken mechanically with glass beads for 24 hours, and extracted in the incubator for 10 days, during which the tightly-stoppered container should be shaken up at least once a day. The extract is then filtered through fat-free paper or paper washed with ether and alcohol. The filtrate is measured, and the loss by evaporation made up by addition of alcohol. In the absence of a shaking apparatus, extractions may be left in the incubator a few days longer. The sediment should not be removed or disturbed.

Aqueous extracts of syphilitic livers and alcoholic extracts of normal organs (usually human or beef heart muscle) have also been used, and antigens of greater sensitiveness have been devised, *e.g.*, Emery's improved antigen, prepared by adding to a 10 per cent. alcoholic extract of heart muscle a 1 per cent. alcoholic solution of cholesterol in the ratio of 5:4. The cholesterol-reinforced extracts, while more sensitive than others, are more likely to yield occasional faintly positive reactions with non-syphilitic serums; repeated negative results with such extracts, on the other hand, have increased value for determining the completeness of treatment in syphilitic cases.

*Technique of the Reaction.*—The preparation of the antigen and the red corpuscles has already been described (sheep corpuscles are, however, generally substituted for the human corpuscles). The complement is furnished by fresh, clear guinea-pig serum, which is diluted with 9 parts of normal saline solution. The amboceptor is supplied by the serum of a rabbit immunized by intraperitoneal injections of washed sheep's corpuscles (5 injections of 1, 2, 3, 4 and 6 c.c. at 5-day intervals, the

serum being obtained 9 days after the 5th injection). The rabbit serum is heated to 55° C. for ½ hour, then mixed with an equal volume of C. P. glycerin and sealed in 1 c.c. sterile ampules. Before use this amboceptor requires to be titrated. This is carried out thus: In 6 test-tubes place, respectively, 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3 c.c. of diluted amboceptor made by adding the contents of 1 ampule to 200 c.c. of salt solution. To each tube then add 1 c.c. each of the diluted complement and the corpuscle suspension, together with enough salt solution to make a total of about 4 c.c. Shake gently and incubate for 1 hour at 37° C. The tube now showing just complete hemolysis contains 1 unit of amboceptor; in the Wassermann test 2 such units are used (Kolmer).

Five controls are practically indispensable for satisfactory results: (1) Known non-syphilitic normal serum substituted for patient's serum. (2) Known syphilitic serum substituted for patient's serum. (3) Antigen control (antigen, at least 0.4 c.c. + complement, 1 c.c. + salt solution, to make 3 c.c.). (4) Hemolytic system control (complement, 1 c.c. + salt solution, 2 c.c.). (5) Corpuscle control (corpuscle suspension, 1 c.c. + salt solution, 3 c.c.). Furthermore, behind each tube containing serum (3 in number: patient's serum, known negative serum, and known positive serum) is placed another tube containing the same serum and hemolytic system except the antigen, which is omitted.

Thus, in performing the test, the antigen (0.4 c.c. or more) is placed into each front tube; 0.2 c.c. of the 3 kinds of serum is placed, respectively in the 3 front tubes and also in the 3 rear tubes; 1 c.c. of the 1:10 complement is then added to each tube, and finally, enough salt solution to make 3 c.c.

The tubes are shaken gently and incubated for 1 hour; 2 units of amboceptor and 1 c.c. of corpuscle suspension are then added to each tube except the corpuscle control. The tubes are shaken, reincubated for 1 to 1½ hours, and a preliminary reading made. If the reactions are only partially positive, the final reading is preceded either by centrifugation or by a sojourn of the tubes over night in the refrigerator (Kolmer).

The results to be expected in the various tubes are these: The 3 rear serum tubes (serum controls), the front tube with negative serum, and also the hemolytic system control and the antigen control, should show complete hemolysis (red color without any sediment of red cells). The corpuscle control should show no hemolysis (corpuscles at the bottom with pale supernatant fluid). The front known positive serum tube and the front tube with patient's serum—if syphilitic—show absence of hemolysis (due to absorption of complement). The results in respect of the patient's serum are commonly graded as +++ or strongly positive (where there is complete inhibition of hemolysis); +++ or moderately positive (75 per cent. inhibition of hemolysis); ++ or weakly positive (50 per cent.); + or very weakly positive (25 per cent.); ± or doubtful (less than 25 per cent.); — or negative (complete hemolysis). (For the interpretation of the results of the Wassermann reaction in the various stages and forms of syphilis, as well as for other serum tests used in this disease, see *SYPHILIS*, Vol. VIII).

The above constitutes the mode of application of the *Bordet-Gengou phenomenon* (absorption, fixation or deviation of the complement) in the diagnosis of syphilis. Serum tests based on the same principle have been applied in a number of other diseases. Such tests will be found mentioned separately under the various disorders concerned.

**The Abderhalden Test.**—This biological test is based on the following principle enunciated by Abderhalden: Where a certain group of cells, or an organ, becomes diseased, material foreign to the blood-plasma may be liberated which will provoke the formation of ferments. Detection of the latter, in turn, will permit of ascertaining what particular organ is involved.

The test may be performed in 2 ways: (1) by the method of dialysis, and (2) by the optic method. In the former procedure, 0.5 Gm. of prepared placental tissue is placed in a specially prepared dialyzing thimble; 1.5 c.c. of the blood-serum under examination, absolutely free from hemoglobin, is put into the thimble and is dialyzed in 20 c.c. of distilled water. The

contents of the thimble and external fluids are covered with a little toluol. The thimble is kept in the incubator for 16 hours. Then 10 c.c. of the diffusate is removed to a dry test-tube and boiled with 0.2 c.c. of a 1 per cent. solution of ninhydrin. If, after standing  $\frac{1}{2}$  hour, the solution remains colorless, the test is negative. If there is a deep violet-blue color, it is positive. Controls with the serum alone and with the tissue alone are employed. In this method careful preliminary tests relative to the permeability of the dialyzing thimbles are essential.

The optic method is carried out with the polariscope, and is simpler; great skill and experience are, however, necessary for making accurate readings.

In 1921 Abderhalden described a simplified procedure in which the serum to be tested is simply poured into a test-tube containing the corresponding organ tissue, sterilized by boiling. In the case of placental tissue, for example, the fluid in the tube, incubated at 37° C., was stated to become turbid and later opaque if the serum was from a woman not too far advanced in pregnancy, while it remained unchanged if the serum was from a non-pregnant woman. Similar results are obtained, according to Abderhalden, from cases of cancer, dementia præcox, paresis, etc.

It is now generally conceded, however, that Abderhalden's theory of "specific defensive ferments" is unproven. F. Hügler and P. Serio (Wien. Arch. f. inn. Med., Mar. 10, 1924) applied Pregl's refractometric modification of the Abderhalden reaction in 300 patients and found that while pathologic serums were generally more active catabolizers, their increased activity was usually directed against several organs at the same time, showed marked variations against a given organ at different times, and could lead to no conclusion as to a specific character of the reaction. Similarly, F. C. Smith and V. J. Shipley (Am. Jour. of Obst. and Gyn., Jan., 1924) found tests on the serums of pregnant women uniformly positive, but also had numerous positive results with serums of men and non-pregnant women, concluding, therefore, that the test is not available for the diagnosis of pregnancy. H., W. and S.

**HEMATOPORPHYRINURIA.**

**—DEFINITION.**—Evacuation of urine containing hematoporphyrin, *i.e.*, a coloring matter resembling hematin, but containing no iron.

**SYMPTOMS.**—The urine is dark red or brown (resembling port wine). The ordinary reactions for hematin or hemoglobin do not give positive results. Examination by means of the spectroscope reveals characteristic absorption-bands. It is accompanied by marked exhaustion, constipation, tympanites, nausea, and intestinal pain. The case may appear relatively unimportant, then suddenly assume a lethal trend. In chronic cases nervous trophic disorders develop.

Case of hematoporphyrinuria with nausea and vomiting, and loss of weight. A sister, 18 years old, had died with the same symptoms, and another sister was now similarly affected. The father had signs of Graves's disease. The patient reported had also enlargement of the thyroid gland, gastroduodenal dilatation, and suffered from tetanoid attacks. Multiple neuritis developed, followed by death from bronchopneumonia. L. F. Barker (N. Y. Med. Jour., June 8, 1912).

A familial, congenital form has been described, beginning in late childhood or middle age and occurring in paroxysms often with intestinal prodromes. A particular feature is the skin lesions appearing after exposure to light—erythema, vesicles, often marked pigmentation, constituting a typical *hydra aestivale* or *vacciniforme*. Coryza, conjunctivitis, edema and diarrhea may coexist. Hematoporphyrin injections have been shown experimentally to produce marked sensitization to light, both in animals and men.

**ETIOLOGY.**—Hematoporphyrinuria may be the consequence of prolonged use of sulphonal, trional or saffron. Other poisons said to have caused it are barbitol, phenobarbital, acetanilid, nitrobenzene and lead.

Case due to excessive use of trional and sulphonal in a man aged 39 suffering from neurasthenia and insomnia. The symptoms were profound exhaustion of body and mind, obstinate constipation, tympanites, nausea,

occasional vomiting, and much abdominal pain, localized around the navel. The urine was scanty and presented the appearance of free blood. The patient died in twenty-five days. He had been taking daily about 12 grains (0.77 Gm.) of sulphonal for four or five weeks with an occasional dose of 15 grains (1 Gm.) of trional. A. W. Rogers (Jour. Amer. Med. Assoc., May 18, 1912).

It is witnessed in some acute fevers, when hemorrhage occurs in the intestine from any cause. It may also be the expression of a constitutional state, *porphyria* or *hematoporphyrinuria*, upon which H. Günther issued a monograph in 1922.

Case of hematoporphyrinuria coming on in attacks, with stinging and burning pains in various parts of the body, ending in death 8 years after the initial detection of hematoporphyrin. In the last 10 years over 20 cases of porphyria or acute hematoporphyrinuria have been reported, affecting women in about  $\frac{2}{3}$  of the cases, with neuropathic or psychopathic basis in  $\frac{1}{4}$ . There is a triad of symptoms, *vis.*, intestinal colic without demonstrable reason, vomiting, and obstinate constipation. The pain usually begins in the epigastrium and often radiates to the loins or lower limbs. The picture may resemble appendicitis, gall-stones, kidney stones or ileus. There is usually retention of gastric contents, with dilatation of the stomach and upper part of the small intestine. The vomitus is often bile-stained. Vesical tenesmus may occur. Fever existed in  $\frac{1}{2}$  the cases. The blood serum does not, as a rule, contain hematin or hematoporphyrin. Attacks usually occur several times a year. A whole series of nervous symptoms gradually appear: Sensory disturbances, neuralgic pains, insomnia, hyperesthetic zones, psychoses, epileptiform attacks, delirium, and finally mild polyneuritic symptoms. Ascending paralysis occurred in about  $\frac{1}{4}$  of the fatal cases. Death usually occurs in a few weeks after the onset. Postmortem findings have been few: Usually liver degeneration

with siderosis, dark bile, fatty and hyperemic kidneys, inconstant and indefinite changes in the nervous system. In the author's case severe arteriosclerosis and nephritis were found; dilatation and secondary thrombosis of the basilar artery were the cause of death. In some acute cases there occur early cerebral symptoms, such as unconsciousness, clonic spasms, hallucinations, apathy, etc. It has been learned that there are several porphyrins; in addition to the one artificially made by treating hematin with hydrobromic acid and glacial acetic acid, a urohematoporphyrin and an entero- or coprohematoporphyrin are found in this disease. F. Harbitz (Arch. of Int. Med., May, 1924).

**TREATMENT.**—This consists in removal of the cause and immediate efforts to reconstruct the blood. In severe cases **transfusion** is necessary. **Hypodermoclysis** with **adrenalin** 1:1000 solution, 20 minims (1.25 c.c.) injected into the rubber tube while the **saline solution** is being injected, may also be tried. **Blaud's pill**, 5 grains (0.3 Gm.) *t. i. d.*, with **adrenal gland** in the same dose, aid to rebuild the hemoglobin. **Alkalies** have been recommended. All prescriptions for trional or sulphonal should forbid its renewal by the druggist without specific orders from the attending physician. L. and S.

**HEMATOXYLON.**—The common name of this drug is logwood. It is the heart-wood of the *Hematoxylon campechi- num*, a small tree, with irregular, spinous branches, growing in Central America and the West Indies. It occurs in reddish-brown chips, has a faint, agreeable odor and a sweetish, astringent taste.

Hematoxylon contains hematoxylin to the extent of 10 or 12 per cent.; also tannic acid, a volatile oil, resin, and calcium oxalate. Hematoxylin occurs in colorless crystals, which become dark red when exposed to light. It is soluble in both water and alcohol, and is used extensively for the staining of histological specimens.

Hematoxylon is incompatible with the mineral acids, opium, tartar emetic, lime-water, ammonia-water, and metallic salts.

**PREPARATION AND DOSE.**—*Extractum hamatoxyli*, N. F. V (extract of hematoxylon), made by macerating 1 part of the drug in 10 parts of water, boiling, straining, and evaporating to dryness. Dose, 15 grains (1 Gm.).

**PHYSIOLOGICAL ACTION.**—Hematoxylon is an astringent and is also credited with a slight antiseptic action. It tends to coagulate albumin. It imparts a red color to both the urine and the stools when given internally.

**THERAPEUTICS.**—Externally, the extract is said to be of value in **ulcers** and **gangrenous conditions**. On account of its astringent action it may be used locally for the relief of **leucorrhœa** and is also sometimes used for **hemorrhoids**.

Internally, the extract is used in **diarrheal conditions**, being of particular value in tuberculous diarrheas. It may also be given in nervous diarrheas and diarrheas occurring in young children, its relatively pleasant taste facilitating administration. It may be given in combination with other astringent drugs. H.

**HEMATURIA.—DEFINITION.**—Evacuation of urine containing blood.

**SYMPTOMS.**—Urine containing but a little blood may not give any indication of its presence to the naked eye; but when the quantity is larger, it presents a characteristic smoky appearance; when more abundant the fluid has a more or less pink or red color, while the surface presents a tinge of green; in extreme cases it looks almost like pure blood. After a time a brownish or grayish, gum-mous, flocculent sediment is deposited. When the blood is abundant it often separates from the urine in distinct clots. Other coloring matters in the urine may simulate hematuria, *viz.*, phenol, santonin, bile-pigment, the coloring matter of rhu-barb, senna, etc.

**Tests.**—The presence of blood may be proved by different tests.

**Heller's Test.**—A few cubic centimeters of urine are rendered alkaline with caustic soda and heated in a test-tube to the boiling point; when blood is present the fluid becomes dark green; the phosphates are deposited as a flocculent sediment, carrying with them the coloring matter of the

blood by which they are colored red, or, rather, rusty brown. The alkaline solution of hemoglobin is dichroic; it shows a green tinge in thin layers and a red in thicker ones, while in the alkaline solution of santonin the coloring matter of rubarb, chrysarobin, rhamnus, senna, etc., is not dichroic and takes on a violet hue after a time. In alkaline urines this method often produces no precipitate because the phosphates and carbonates have already separated out spontaneously. The necessary quantity of phosphates and carbonates may be supplied by adding to the specimen about an equal volume of a normal urine (Sahli).

*The Guaiac Test (Almén-Schönbein).*—One cubic centimeter of recently prepared tincture of guaiac is carefully mixed with an equal volume of ozonized oil of turpentine, i.e., turpentine oil which has for some time been exposed to the influence of air. The mixture is cautiously poured upon the specimen of urine to be tested and will superpose itself, forming at the point of contact a gray or greenish layer; when blood is present a beautiful indigo-blue stratum will appear immediately above the gray ring; when shaken the mixture will take a light-blue color. Before making the test, we should see that the urine is acid or is made so by adding acetic acid. The guaiac test is very delicate, indicating blood in the proportion of 1:2000 or less and will sometimes give a positive result when the spectroscopic test fails.

*The Benzidin Test (Schumm).*—Ten c.c. of the suspected liquid is treated with 1 c.c. of glacial acetic acid. To this is added a third volume of ether. The supernatant ether is transferred to another test-tube containing a mixture of 0.5 c.c. of a glacial acetic acid solution of benzidin and 2 c.c. of hydrogen dioxide. If blood is present, the reagent turns green or blue, and then, in five minutes, a dirty purple.

*Florence Test (for spermatic fluid).*—To the suspected substance add a strong aqueous solution of iodine and potassium iodide. If spermatic fluid is present, brown plates or needles will be formed.

*The Hemin Test (Teichmann).*—Some of the sediment of the urine or of the red phosphates deposited after addition of

caustic soda is collected and dried. A small amount is placed on a glass slide and completely dried by slowly warming. When it is fixed on the surface of the glass, some common salt is rubbed on it, a fine hair is placed across the preparation, a few drops of glacial acetic acid are added, and the whole is covered with a cover-glass. The glass slide is heated to the steaming—not the boiling—point for one minute. A little acetic acid is added from time to time to make up for evaporation. If the fluid turns brown, it is warmed gently and then allowed to evaporate. When blood is present the characteristic small, reddish-brown crystals of hemin will appear, which are easily detected by the aid of the microscope.

*Spectral Analysis.*—Examination of a stratum of urine containing oxyhemoglobin 1 or 2 c.c. thick by transmitted bright daylight, sunlight, or lamplight through the spectroscope reveals two distinct absorption-bands between the lines *D* and *E* of Fraunhofer; recently passed urine never contains oxyhemoglobin, but methemoglobin (a modification of hemoglobin containing more oxygen than hemoglobin, but less than oxyhemoglobin). By decomposition of the urine or by addition of a solution of ammonia the methemoglobin is reduced to hemoglobin, which again forms oxyhemoglobin when shaken with air. The methemoglobin gives rise to the same two absorption-bands as the oxyhemoglobin, but, besides, to a characteristic band in red, between *C* and *D*. For clinical purposes a small hand spectroscope may be used. If the urine be dark or cloudy it must first be diluted with water. When the urine contains a very small amount of blood-pigment, an acetic acid solution of the hematin-containing precipitate obtained in Heller's test can be used for spectroscopic examination. The hematin bands will be seen. This method may also be used when the urine is so deeply colored from the presence of bile-pigments or urobilin that the hemoglobin or methemoglobin bands cannot be seen (Sahli).

*Microscopic Examination.*—This is the most reliable test for hematuria. The urine is centrifuged and the sediment examined; even when the amount of blood



is too small to alter the color of the urine the corpuscles of blood are easily detected by this method. Ordinarily the corpuscles are normal in appearance, but they do not accumulate in rolls; when the urine is dilute or alkaline, they are large, spherical, and almost colorless, commonly very transparent, whereas in concentrated urine their contour is irregular and indented; in some cases the corpuscles are broken up (*fragmented*); in others casts of renal tubuli formed by blood-corpuscles may be seen. The urine, naturally, is albuminous.

The admixture of blood to the urine may take place in the kidneys, the ureters, the bladder, or the urethra; in order to ascertain the origin of the blood, it is necessary to subdivide the urine when voided into several parts. The first portion voided may contain blood of urethral origin, and the urine last voided show none whatever.

When the portion last obtained contains much more blood than the first, the bladder probably is the seat of the bleeding. The endoscope will then generally allow the direct inspection of the bleeding-point on the mucous membrane of the bladder.

When the bleeding is caused by lesions of the ureters or of the calyces, cylindrical coagula or casts of the calyces may be found in the urine.

When the bleeding has taken place in the kidneys the blood is very intimately mixed with the urine; the corpuscles are often broken up or massed together, and casts of the renal tubes are commonly found.

**ETIOLOGY.**—Hematuria is more frequently observed in men than in women or children. The blood in hematuria may come from the kidneys, their pelves, the ureters, the bladder, or from the urethra.

Bleeding from the anterior urethra may be caused by acute or chronic gonorrhea, by traumatism (calculi, introduction of catheter), by polypoid excrescences, stricture, warty growths, tuberculous ulcers, or malignant tumors. In the posterior urethra the bleeding may come from enlarged or inflamed verumontanum, posterior urethritis, or inflammation of the prostate or seminal vesicles. The inflammation of the prostate may be gonorrheal, tuberculous, mixed infectious, or syphilitic (*gumma*). The seminal vesiculitis

may be cancerous, or due to mechanical violence or to stone.

Hematuria has been observed as a result of venereal excess or as an accompaniment of the first coitus after a long period of abstinence.

The causes of bleeding from the bladder are traumatism (*calculi*); diseases of the bladder, acute or chronic; varicosities of the veins (*vesical hemorrhoids*); ulcerations of the mucous membrane, diphtheritic or tuberculous; tumors, especially cancer of a villous or fungous nature; parasites, such as *Distoma haematobium*, or *Bilharzia*, and *Filaria sanguinis*; it may also occur in hemorrhagic diathesis, in hemophilia, and also in infectious fevers, variola, etc.

Bleeding from the pelves or the ureters is generally caused by calculi or by tuberculous disease; also by acute infectious diseases of hemorrhagic character; by parasites (*distoma* and *filaria*).

Bleeding from the kidneys is frequently due to irritating poisons, such as cantharides, turpentine, hexamethylenamine, etc.; very large doses of quinine and of salicylic acid are said to have produced renal hematuria.

Gross hematuria may occur in acute fevers and microscopic blood may be present during convalescence. Cardiovascular disease, various purpuras (including scurvy), syphilis, nephritis, malaria and many other conditions may cause transient or intermittent hematuria, as may methenamine, phenol, and barbitol.

Such causes of hematuria as appendicitis and other extrarenal conditions, varices of the bladder, hydronephrosis, especially with mobility of the kidney, and polycystic kidneys one may diagnose with certainty from the findings of routine examination. Varicosities and angiomas of the renal pelvis one can scarcely expect to prove without exploratory operation. The etiology of protracted hematuria in many members of a family, without apparent specific cause, remains theoretical. A. R. Stevens (*Jour. Amer. Med. Assoc.*, Oct. 14, 1922).

Case in a man of 36, who always had marked hematuria after exercise ac-

accompanied by exposure to cold, with no findings in the urinary tract. Tuberculous cystitis causing hematuria is not influenced by rest or exercise and is never profuse. It begins with frequency and microscopic bleeding. Pain is a late symptom, but becomes intense. Cystoscopy and microscopic examination are the only means of absolute differentiation from other forms of cystitis. In vesical tumor the degree of bleeding gives no indication of the size of the growth or whether it is malignant. All bladder tumors grow slowly, and when bleeding stops the patient may be lulled into a false sense of security. Renal calculus is accompanied by hematuria in about 40 per cent. of cases. T. J. McBee (*W. Va. Med. Jour.*, Mar., 1924).

Analysis of 821 cases of hematuria. Pyelitis had been the cause in 132 cases; kidney tuberculosis, in 88; kidney calculus, 64; ureteral calculus, 87; cystitis, 38; vesical calculus, 38; tumor of bladder, 87; chronic inflammation of prostate with tuberculosis, 39; prostatism, 54. In 60 cases the blood came from the urethra. Excluding the urethra, 536 cases out of 761, i.e., over 70 per cent., were due to calculi, tuberculosis, cancer or surgical lesions of the kidney. D. W. MacKenzie (*Surg., Gyn. and Obst.*, Aug., 1924).

Case in which the entire kidney capsule was found separated from it by a layer of blood. Histologic examination showed congenital abnormalities in the walls of the arteries in the parenchyma, allowing diapedesis. The extravasation had probably progressed since childhood. Vague pains at times had not been heeded until the age of 19, when, after 5 days of intense suffering and hematuria, the kidney was removed. P. Janssen (*Zeit. f. urol. Chir.*, Oct. 3, 1924).

The majority of gross hematurias are of bladder origin and symptomatic of tumor, while the majority of microscopic bleedings are the result of inflammatory lesions primarily resident in the upper urinary tract. Simple inflammation, calculus formation and tuberculosis account for more than

twice as many renal hematurias as all other lesions combined, including tumors. The author found renal tumors responsible for 15 per cent. of renal hematurias. Ureteral calculi cause microscopic bleeding oftener than gross bleeding. About 3 per cent. of renal hematurias are due to traumatic injury, while 7 per cent. are attributable to essential bleeding, hydronephrosis, movable kidney, simple cyst, polycystic kidney, echinococcus cysts and other rare conditions. In chronic interstitial nephritis hematuria is rare. Chronic pyelitis, especially of the granular type, may cause excessive bleeding through congestion and rupture of small, newly formed vessels. Renal congestion due to pressure on the pedicle by extrarenal tumors, suprarenal tumors, aneurism and renal torsion accounts for a small number of renal bleedings. Sudden, profuse renal hemorrhage, unassociated with other symptoms, is usually indicative of tumor. Leon Herman (*Jour. Amer. Med. Assoc.*, Oct. 25, 1924).

Different diseases of the renal blood-vessels may cause bleeding; for instance, embolism of the renal artery, thrombosis of the veins, aneurism, traumatism, and chronic interstitial nephritis.

The writer classifies hematuria according to its causation: 1. Traumatic, including accidental injury and that from stones. 2. Inflammatory, including acute nephritis, chronic inflammatory affections of the kidney, tuberculosis, acute and chronic inflammation of the pelvis of the kidney, ureter, bladder, prostate, and also of the urethra. 3. Vascular, blood dyscrasia, such as hemophilia, etc.; nevi, venous obstruction of the kidney; varicosity of the vesical veins, especially that due to prostatic engorgement. 4. Chemical, namely, from irritating drugs, as turpentine, cantharides, etc. 5. Toxic, in which the hemorrhage was the result of vascular changes in severe toxemias, as in malaria, acute yellow atrophy of the liver, yellow fever, scurvy, etc.

6. Neoplastic. 7. Parasitic. Renal hematuria was probably the form most interesting to the surgeon. Laceration of the kidneys, gunshot or stab wounds, frequently caused hemorrhage which appeared in the urine. J. G. Sherrill (N. Y. Med. Jour., Oct. 11, 1913).

Bacterial infection, particularly colon bacillus, is not infrequently a cause of unilateral bleeding. Billings reports 2 cases of this type, both of which were cured by the injection of colon vaccines, thus proving the etiology. Elliott also believes that the colon bacillus can induce a painless hematuria. White coincides with these writers as to the etiological importance of the colon bacillus.

In 11 cases of "essential" hematuria the writers always found an overgrowth of connective tissue, caused probably by localized inflammation, at the corticomedullary junction in the kidney. Sections showed thrombosed and even ruptured veins. If **styptics** to the renal pelvis fail, **nephrotomy** should be done. Cure resulted in each of 8 cases. Payne and MacNider (Jour. Amer. Med. Assoc., Sept. 23, 1916).

Parasites (*Distoma hematobium*, *Filaria sanguinis*, echinococcus); also more rarely acute nephritis, especially scarlatinous. In Bright's disease hematuria is observed also when malignant neoplasms are present. Renal hematuria may be caused by scurvy, hemophilia, etc.; it occasionally accompanies infectious diseases, such as variola, morbilli, scarlatina, typhoid fever, cholera, exanthematous typhus, recurrent fevers, yellow fever, erysipelas, etc.; it is rarely seen in syphilis, but in intermittent fever it is a frequent symptom (see **MALARIAL FEVERS**).

Family of 17 persons, of three generations, 10 of whom suffered from attacks of hematuria. There was no history of hemophilia in the family. Six children of the last generation all suffered from hematuria, in all probability, ever since birth. The attacks were accompanied by fever, and might be brought on by slight colds. J. Aitken (Lancet, Aug. 14, 1909).

Analysis of 13 reported cases from the literature. The writer finds that in 6 the hematuria was due to adhesion of the appendix to the ureter. In 3 the inflammatory process involved the kidney; in 2 cases the hematuria was ascribed to toxemia, and in the remaining 2 no cause could be discovered. He reports 2 additional cases. A. von Frisch (Wiener klin. Woch., Jan. 4, 1912).

The writer has encountered a case of pregnancy hematuria, blood being found in the urine for a few weeks during the third month of the woman's second pregnancy. Bed rest, restriction to milk, and injection of 10 c.c. (2½ drams) of inactivated rabbit-serum had no effect on the hematuria. The blood came exclusively from the left kidney and amounted to an average of 20 Gm. a day. The patient had a valvular affection which forbade general anesthesia for decapsulation or nephrotomy, and there seemed no resource except to interrupt the pregnancy. As soon as the uterus was emptied the hematuria gradually began to subside. The writer has found 18 other cases of pregnancy hematuria on the records of his hospital. Analysis of this material confirms the view that the pregnancy is liable to induce hematuria by the active and passive hyperemia or by the autointoxication, but that this does not occur unless the kidney is already diseased. Treub (Monats. f. Geburtshilfe u. Gynäk., xxxvi, Festschrift, 1912).

Case of hematuria from tuberculosis of the patent urachus. The diagnosis was made first of an infected tuberculous cyst of the abdominal wall and it was excised. The wall of the excised cavity appeared infected. The open end of the patent urachus was found and this organ was excised, taking a portion of the mural peritoneum with it, down to the bladder fundus, where the heavy, cord-like, tubular structure widened and fused. The cord and bladder fundus for an inch on all sides of the opening were removed, and the bladder-wall was

infolded and closed with catgut sutures. After closing up the wound, the patient did well and the hematuria did not reappear. H. E. Pease and E. L. Miller (Jour. Amer. Med. Assoc., June 1, 1912).

The author's 2 patients were young men who had a history of serious hemophilic hemorrhages in previous years; in both the hematuria came on a few hours or two days after a steam-bath with massage or a superheated-air bath. The urine filtered without leaving any sediment, so that there must have been hemolysis as well. One patient was quieted with **morphine**, and the tendency to hematuria subsided under **gelatin** internally, **ergot**, **epinephrin**, and **castor oil**. This patient died suddenly a few months later from acute heart-failure. The hematuria kept up in the other patient notwithstanding the usual measures, including subcutaneous injection of **horse-serum**. Then, at a consultation, Kussmaul's old experience was recalled: He failed constantly on account of hemorrhage, in some experiments on dogs, until he kept the dogs from drinking, feeding them abundantly, but giving them little if any water. On this **dry diet** the blood became so much thicker that there was no further tendency to hemorrhage. The writer acted on this suggestion in this rebellious case of hematuria, and the hematuria ceased as the patient refrained from fluids. He had the heroism to refrain for two weeks from drinking, and his food was prepared as dry as possible. The blood and organic juices thus became more concentrated, and contained proportionately more coagulable substance. The result was complete subsidence of the manifestations of hemophilia. O. Mankiewicz (Zeit. f. Urologie, Nov., 1913).

In some cases the hematuria is idiopathic, and is not to be explained by any of the above-mentioned etiological factors.

**DIAGNOSIS.**—Two factors enter into the question of diagnosis in hematuria,

the location and the character of the lesion giving rise to the bleeding.

**Urethral.**—The location and character of lesions giving rise to hematuria from the urinary tract anterior to the bladder may usually be determined by the aid of the urethroscope.

**Vesical.**—In vesical hemorrhage from trauma, the history of the case will usually enable us to make a correct diagnosis, except when the hemorrhage is caused by the presence of a calculus, as in the latter case, as well as in trauma, the hematuria usually disappears after a good rest in bed, while motion increases it. The presence of the calculus, however, may easily be made known through the use of a searcher, cystoscope, or the X-rays.

Parasitic hemorrhage may be revealed by finding the characteristic ova (e.g., *Distoma hematobium*) in the urine. If due to filaria the urine will be chylous.

Bacillary hematuria is revealed either by discovering the bacilli (tubercle or colon) in the urine, or by inoculating guinea-pigs. If the bleeding comes from a tuberculous ulcer, the latter may be discovered through the use of the cystoscope.

While it is usually a fact that in renal hematuria the urine is more apt to be dark than bright, there are many exceptions to the rule. The microscopic finding of pelvic or renal epithelia with red corpuscles is strong evidence that the source of the hemorrhage is renal, while the absence of pelvic and renal epithelia and the presence of bladder cells from the different layers of the vesical mucosa would strongly indicate the bladder as its source.

**Renal and Ureteral.**—When the kidney is the source, renal casts in the bloody urine, particularly if the casts have blood-corpuscles lying on or in them, will usually make the diagnosis clear. If we are in doubt cystoscopy and microscopic examination of the urine will reveal the origin of the hemorrhage as between vesical and renal. If the cystoscope discloses bloody urine pouring out of one or both ureters, the source may be either renal or ureteral. This the ureteral catheter will decide. If the catheter be passed within the pelvis of the kidney on both sides, and clear urine comes from one and bloody urine from the other, the lesion

is usually on the latter side and the source is the pelvis or the kidney structure. This, however, is not infallible, for often with two kidneys equally diseased by the same pathological process only one may cause bleeding. On the other hand, if clear urine comes from both catheters the lesion is in the ureter and its location may be learned by slowly withdrawing the catheters until blood appears in one or both specimens.

Hematuria of renal origin may be caused by malignant disease, calculus, tuberculosis, or nephritis.

When due to malignant disease, the patient is generally past 40 years of age, the hemorrhage is frequently profuse and is increased by exercise, but is little, if at all, diminished by rest.

For the positive diagnosis of sarcoma, large shreds of connective tissue and numerous characteristic sarcoma corpuscles must be found in the urine before ulceration occurs, perhaps by immigration, but unless they are very numerous the diagnosis is not positive unless large connective-tissue shreds are found at the same time (Heitzmann).

Renal calculus occurs early in life, and there is generally a previous history of the passing of a renal stone or gravel. Profuse bleeding is unusual. There may be no accompanying pain. The bleeding is increased by exercise and diminished by rest. The X-ray will, however, remove all doubt as to diagnosis.

Renal tuberculosis as a source of hematuria commonly occurs in early adult life, but may not until later. The hemorrhage is most often small in amount and intermittent in its appearance, although it may be profuse and continuous. Palpation will often reveal a tuberculous kidney, as it is generally enlarged and tender to the touch. There may be lumbar pain.

Associated with the blood, we will find in renal tuberculosis pus and pelvic epithelia, and careful microscopic examination may reveal tubercle bacilli in the urinary sediment. Inoculation of guinea-pigs with the urine will remove doubt.

In short, by microscopic examination we first find the source and cause of the blood in the urine, and then confirm our findings by the use of the urethroscope,

cystoscope, ureteral catheter, the X-ray, shadowgraph catheter, pyelography, and tests for renal efficiency.

Stress laid on the importance of seeking the source of the hemorrhage in every case, cystoscopy being of the greatest aid to that end. To allow these cases to go unstudied until the bleeding has ceased often delays the correct diagnosis for an indefinite period. Certain definite contraindications to a cystoscopic study exist, but if none of these are present it should not be postponed. Pelouze (*Atlantic Med. Jour.*, Oct., 1924).

Cystoscopy may rule out vesical causes for bleeding and determine whether the bloody urine is coming from 1 or both ureters. This separates bilateral hematurias, which have a constitutional or systemic etiology, from unilateral hematurias, which are usually due to a local pathologic condition. Bilateral hematuria may be due to subacute hemorrhagic nephritis or to nephritis caused by focal infection, and may then yield to appropriate treatment. In unilateral hematuria, the cystoscopy should be supplemented by any or all of the following: X-ray examination, with or without the opaque catheter and injection of opaque media; the wax-tipped catheter or bougie; the ureteral catheter; comparative functional tests, and therapeutic tests. Every case of hematuria should be regarded as due to neoplasm until proven otherwise. Cases in which pyelography shows dilated pelvis and calyces should be suspected of neoplasm of the renal pelvis unless some other cause can be established. In all cases with negative findings in which the simpler measures of treatment fail, or cases in which bleeding recurs, and in all unexplainable pyel ectasis cases, an exploratory nephrotomy with inspection of the renal pelvis is indicated. P. W. Aschner (*Amer. Jour. Med. Sci.*, Feb., 1924).

**PROGNOSIS.**—The prognosis of hematuria depends on the quantity of blood lost and the gravity of the disease which causes the bleeding.

**TREATMENT.**—In all forms of hematuria **rest** and **cold** are the most important therapeutics, with a liquid diet of milk or buttermilk, and diluting drinks to lessen the tendency to coagulation and favor a soft, free stool; in bleeding from the urethra and the bladder cold may be applied by injections of **ice-water** or externally; in *bleeding from the urethra* **compression** may be useful; also astringent injections have been employed (**nitrate of silver**, 1:2000, given warm; **acetate of lead**, **tannic** or **gallic acid**, **perchloride of iron**, **adrenalin solution**, etc.); when the bleeding is accompanied by *painful micturition*, **narcotics** are recommended.

Bleeding from the *ureters, pelvis, or kidneys* is treated by **rest**, **cold**, daily intravenous (15 c.c.) or subcutaneous (30 c.c.) injections of fresh human or animal **blood-serum**, and internal medication of **calcium lactate**, **hexamethylenamine**, **secale**, **ergotin**, **tannic** or **gallic acid**, **arbutin**, **acetate of lead**, **perchloride of iron**, **adrenalin**, **fluidextracts of hamamelis Virginia** or of **hydrastis Canadensis**, 1 ounce to the pint, warmed. In *chronic cases* of hematuria the **balsams** may be tried.

The first indication, at least to the patient, is to stop the bleeding. This bleeding may be dangerous, but rarely fatal. When due to *renal calculus*, absolute **rest**; **cold**, **acidulous drinks**; **hot applications**, and, if much pain, **morphine**, from  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.008 to 0.016 Gm.) hypodermically, may be given. Hemorrhage from *acute congestions* requires **hot fomentations**, **saline laxatives**, and **diaphoretics**; *vesical hemorrhage*, **cold applications** to the **hypogastrium**, with **ergot** by mouth, or **washing out the bladder** with astringents, as **alum**, 2 grains (0.13 Gm.) to the ounce (30 c.c.), after the bladder has been emptied. When due to *malignancy*, **operation** is needed at once if the disease has not gone too far. *Tuberculous disease* requires the same care as when it affects other portions of the body. *Injuries*, if not severe, require **rest** and **cold applications**; but if serious, **operation** must be attempted. *Constitutional causes* re-

quire general treatment, as in *hemophilia* the **calcium salts** are necessary. But each case requires careful examination and study, with treatment appropriate to its own peculiar needs. W. B. Gibb (N. Y. Med. Jour., June 1, 1912).

*Prostatic hemorrhage* may often be relieved by **opium suppositories** in the rectum and by **cold suprapubic compresses**.

A case of unilateral renal hematuria, of supposed traumatic origin, of sixteen months' duration, and without evidence of nephritis, cured by **adrenalin**. Pain was constant on the right side, the side of the injury, but the hemorrhage was from the left kidney. Adrenalin was injected through the ureteral catheter; only 1 injection of 6 c.c. ( $1\frac{1}{2}$  drams) of a 2 c.c. (32 minims) adrenalin in 8 c.c. (2 drams) of sterile water was given. Some pain was caused at first, but soon disappeared, and the urine cleared up entirely in about ten days, and there was a general improvement in the patient's condition. Three months after the treatment the man was in almost perfect health. H. H. Young (Jour. Amer. Med. Assoc., May 18, 1907).

Permanent relief in *essential* hematuria is usually obtained by **renal decapsulation** or **nephrotomy**. Before this is employed, **tuberculin** should be tried as well as, usually, **turpentine** or other medicinal measures. Babcock (Monthly Cyclo. and Med. Bull., May, 1912).

Nephrectomy is contraindicated unless there is danger of death from hemorrhage; nephrotomy is always contraindicated; and if non-operative measures, such as **rest in bed**, **internal administration of turpentine**, injection of **adrenalin** into the renal pelvis, fail, **decapsulation**, or **pyelotomy**, or both are preferable to nephrotomy or papillectomy. B. S. Barringer (Amer. Jour. of Urol., May, 1912).

The great importance and the grave possibilities of even minute degrees of urogenital hemorrhage em-

phasized. No bleeding is so scanty but that it merits immediate investigation: Pedersen (N. Y. Med. Jour., May 3, 1913).

Ureteral stricture, usually caused by an inflammation secondary to some distant focus of infection, is an important factor in the "essential" hematurias. **Ureteral dilatation and care of focal infections** will be the future treatment for most of these hematurias. Hunner (Jour. Amer. Med. Assoc., Nov. 18, 1922).

In 2 cases, persistent hematuria disappeared in 2 and 5 days after the renal pelvis had been treated with a 5 per cent. solution of **silver nitrate** as a last resort before the contemplated operation. Van Houtum (Ned. Tijds. v. Gen., June 14, 1924).

Case of hematuria in a man of 35, due to a polypoid condition of the colliculus, in which the use of the d'Arsonval **fulguration** tip was promptly successful. In another case, a bleeding varicose vein in the vault of the bladder was dealt with by **ligation**. W. S. Pugh (U. S. Naval Med. Bull., Sept., 1924).

In a boy of 10 years with hematuria of 3 months' duration and laboratory evidences of nephritis, the bleeding was arrested within 3 days by oral and later subcutaneous use of **fibrogen**, described as a tissue fibrinogen or natural coagulant isolated according to the technique of Mills. The dose was 1 c.c. (16 minims). M. K. Willoughby (Med. Jour. and Rec., Oct. 1, 1924).

In essential hematuria, peristalsis of the renal pelvis and hyperemia due to nervous influences are major factors. For bleeding in the renal pelvis flushing of the pelvis with **silver nitrate** solution is of value; in parenchymatous bleeding **renal decapsulation** is more likely to be effective. **Nephrectomy** should be thought of only if these procedures fail. The possible value of **antisiphilic treatment** should be kept in mind. Scheele and Klose (Arch. f. klin. Chir., Feb. 28, 1925).

To check hematuria in pyelonephritis, simple **ureteral catheterization** was found a very effective ad-

junct to the customary measures. H. Blanc (Jour. d'urol., Aug., 1925).

When the bleeding is caused by **calculi** or by **tumors** these are to be **removed** by operation, if possible; when the blood comes from the kidneys and only *one kidney* is *diseased*, it may be necessary to **remove the diseased kidney**; in some instances only an **exploratory incision** has been made, the kidney has been replaced after a careful examination by which no reason for the bleeding was found, and the operation has resulted in complete recovery. (For the treatment of malarial hematuria see **MALARIAL FEVERS**.) L. and W.

**HEMOCHROMATOSIS.**—This rather rare condition is characterized by an accumulation of free iron-containing pigment (hemosiderin) in certain organs and in the skin, together with hepatic and pancreatic fibrosis, and glycosuria in some cases. In a well developed case there is an obvious rusty color of the liver, pancreas, and retroperitoneal glands. Even in other organs not obviously pigmented, the Prussian blue iron reaction may be obtained. The peripheral lymphatic glands usually show little or no coloration, and there is no hyperplasia of the red bone marrow—a distinguishing feature from pernicious anemia and other hemolytic conditions in which free iron is deposited in the viscera. There is no evidence of alteration in the total amount of iron in the blood, although in the liver iron may constitute 7 per cent. of the dried substance of the organ, *i.e.*, about 100 times the normal percentage. No iron has been discovered in the urine, and in the feces a subnormal amount has been found. The condition is ascribed to a congenital metabolic peculiarity (Dunn).

Hemochromatosis may possibly be detected in early cases during life from a slight pigmentation of the skin, but most of the recorded cases have been advanced, with characteristic pigmentation, suggestive of Addison's disease or vagabond's disease, and frequent glycosuria. As stated by Blanton and Healy, who analyzed 75 cases in the literature, the condition affects men during middle life almost exclusively. The only certain method of diagnosis is microscopic demonstration of iron-reacting pigment in the skin. Ascites was present in

18 of the 75 cases. The condition may be combined with cancer of the liver. In most instances the liver is enlarged, the spleen in a smaller ratio of cases. These authors regard the condition as due to some toxic agent injuring simultaneously the red blood cells and the parenchymal cells. Mallory has ascribed it to chronic copper poisoning.

The term "bronzed diabetes" is sometimes applied to these cases where glycosuria coexists, and the terms "pigmentary cirrhosis," where there is evidence of interstitial hepatitis. Cases combining the clinical manifestations of pigmentary cirrhosis and Addison's disease have been reported.

No effectual treatment is known.

(See also PORTAL CIRRHOSIS WITH PIGMENTATION, Volume III, p. 406.) S.

**HEMOCLASIS.**—This term was applied by Vidal in 1920 to a phenomenon consisting of diminution of the leucocytes, together with lowering of blood-pressure and retardation of coagulation, which follows the ingestion of 200 Gm. of milk on an empty stomach. He observed this phenomenon in all manifest as well as latent diseases of the liver. Many investigations and reports followed Vidal's description of it. Most observers have not found it as specific as an indicator of hepatic disturbance as its sponsor maintained. Feinblatt (Arch. of Int. Med., Feb., 1924) applied the test in a group of 50 patients with miscellaneous conditions. The subjects abstained from food at least 5 hours before the test, and after the drinking of the milk the leukocytes were counted every  $\frac{1}{2}$  hour for 2 hours. Normally, the count never fell below the prealimentary level. Leukopenia, when it occurred, usually appeared in the 1st hour. It was found that the hemoclastic crisis may occur in patients who show no clinical evidence of hepatic disease. The test should, according to Feinblatt, not be considered as relating to liver function in general, but merely to the proteopexic function of that organ, whereby, as stated by Vidal, the peptones, proteoses, etc., found in the portal vein during digestion are rendered innocuous and kept from entering the general circulation as split protein products which will disturb colloid balance and bring on the hemoclastic crisis. Frequently the proteopexic function is de-

ficient when there is no other evidence on which to indict the liver. The functional defect indicated may be transitory.

The hemoclastic crisis being generally considered a manifestation of anaphylaxis or protein shock due to entrance of colloids into the circulation, the terms *colloidoclasia* and *colloidoclastic crisis or shock* have also been used. Other manifestations included in the syndrome are inversion of the leukocytic formula, decreased number of blood platelets, and changes in the refractile index of the blood serum. Lumière regarded colloid shock as due to flocculation, i.e., the formation of a fine precipitate in the blood stream. S.

**HEMOGLOBINURIA.—DEFINITION.**—Evacuation of urine containing the hemoglobin but no corpuscles. The disease is also known as **blackwater fever**, when of malarial origin.

**SYMPTOMS.**—Idiopathic, or paroxysmal, hemoglobinuria shows attacks and free intervals of days, weeks, or months. Two attacks have rarely been observed in one day; they are ordinarily caused by cold, especially exposure of hands or feet. The attacks last from three to twelve hours, and are preceded for a brief period by a chill or rigor, itching of the skin, languor, a sense of weight or dull pain over the kidneys, aching pain or stiffness in the legs, and nausea or vomiting. Shivering sets in and generally there is fever, with rise of temperature to 40° C. (104° F.) and still higher. The fever continues for some hours and ends with profuse perspiration. The attacks are sometimes followed by an eruption of urticaria. The urine becomes dark and remains so for some hours. The liver and the spleen have in most cases been found swollen and tender. After the attack the patient is exhausted for some time, with the skin and mucosæ pallid.

The general symptoms of attacks are described by Stempel as follows: The patient is usually pale, anemic, weak, and poorly nourished, perhaps with a hemic murmur of the heart, although many of the patients are rather pale, but otherwise well and strong. Beaumetz, Murri, and Kast describe their cases as being of a healthy, rosy color. A light icterus often



exists, even in periods between attacks. In the large majority of cases certain prodromal signs precede the attack and enable the patient to foretell with certainty the approach of the hemoglobinuria. These signs are exceedingly variable, and we find drawing pains in the kidney region (Greenhone, Eichbaum); frontal headache (Rosenbach, Murri); pain in the right breast, liver, and splenic region (Boas and Struburg); pain in the kidney region, anxious feeling about the heart, sense of exhaustion (Potain); belching gas, pain in the region of the stomach (Gillespie); pain in the back and feet (Frazer); shortness of breath, cyanosis, "things turning black before the eyes," drawing in the limbs, feeling of oppression (Wolff); frequently incessant yawning; especially characteristic is a pronounced feeling of illness, weakness, and heaviness in the limbs. There is usually a slight acceleration of the pulse, without a rise of temperature. The urine up to this time is clear; in some few patients the presence of albumin can already be detected. The typical attack is almost invariably introduced by chilliness, which varies from a slight feeling of cold to a hard, shaking chill; sometimes it manifests itself only as cold feet, numbness of the fingers, or blue coloring of the field of vision (Bristance, Laycock). It is exceedingly seldom that the chilly symptoms are absent. During the shaking chill, or perhaps very soon after it passes off, the temperature rises usually to considerable height, the severity of the attack, of course, causing an extreme variation in it. The liver and spleen may be somewhat enlarged and tender, but pressure over the kidney very rarely produces pain. The attack terminates with a more or less free outbreak of perspiration; the malaise fades away, and there remains only a feeling of dullness and relaxation. This description applies to a typical attack, but often the attacks are much milder and many of these symptoms may be absent. Several authors have observed an urticaria coincident with the attack (Ballenger).

**ETIOLOGY.**—Hemoglobinuria can experimentally be caused by injection, into the veins of animals, of dissolved hemoglobin or of substances which disintegrate

and dissolve the corpuscles of blood, such as water, glycerin, and the salts of the bile-acids; the same results may be obtained by inhalations of arseniureted hydrogen, sulphureted hydrogen, ether, and other poisons, or by ingestion of poisons such as arsenic, chlorate of potassium, etc.; transfusion of blood or serum of another species of animal also causes hemoglobinuria.

In man toxic hemoglobinuria is caused by poisons: *i.e.*, sulphuric acid, hydrochloric acid, arsenic, chlorate of potassium, pyrogallol, naphthol, nitrobenzol, poisonous mushrooms, etc.

Green beans or their flowers, emotional stress, the odor of resin, an infusion of quassia or decoction of absinthe, and figs are credited with having brought on hemoglobinuria. In Ghiompres's fatal case it came on after eating a dish of snails. J. Cardamatis (*Grèce méd.*, vol. ii, Nos. 7-8, 1910).

The condition is frequently a slight one and may escape notice unless looked for; but apart from its mild character it is in all respects the same disease as blackwater fever and should so be regarded. All varieties, including intermediate cases between the transient and the severe and fatal forms of blackwater fever, were met with among the armies in Macedonia. Parsons and Forbes (*Lancet*, Sept. 7, 1918).

It may be caused by extensive burns, insolation, transfusion of lamb's blood, and occur as a symptom of severe infectious diseases (scarlatina, typhoid fever, diphtheria, intermittent fever, icterus). Hemoglobinuria has been observed by Winckel as a special disease of the newborn (see *NEWBORN, DISEASES OF THE*). In severe malarial fevers with icterus, hemoglobinuria has often been noticed; these fevers, known in various countries as blackwater fever (see *MALARIAL FEVERS*), occur mostly in tropical climates in the three continents; when the patient returns to a temperate climate the hemoglobinuria ordinarily ceases; the cases may be light or severe; the severe cases end lethally either by exhaustion, by complete cessation of

the secretion of urine, or by causing a uremic condition of the patient.

Hemoglobinuria is caused by dissolution of blood, *e.g.*, in scurvy, purpura rubrum maculosus, variola hemorrhagica, and may also be seen in typhus.

*Intermittent, or paroxysmal, hemoglobinuria* is a distinct affection which has especially been studied in late years. It has commonly been observed in men, seldom in women, in connection with syphilis, malaria, and Raynaud's disease.

According to Solimena, there are 3 types of hemoglobinuria related to malaria, the spontaneous type, the quinine type, and the mixed type. In his 4 patients belonging to the first group, the hemoglobinuria was promptly cured by quinine. In the 5 of the quinine type, the hemoglobinuria came on 2 or 3 hours after ingestion of the drug and subsided about 24 hours after its suspension. Two patients presented the mixed form. The hemoglobinuria developed soon after a small dose of quinine and was evidently started by the quinine, but was maintained by other factors, the intensification of the symptoms on its suspension and their subsidence on resumption of the quinine justifying this assumption.

According to Cooke, 90 per cent. of paroxysmal hemoglobinurics give a positive Wassermann reaction.

The attacks, which have already been described, vary much in frequency, are usually traceable to exposure to cold, especially of the hands or feet.

The disease is characterized by intermittent dissolution of the red corpuscles of the blood during the attacks. Ehrlich proved this by placing a ligature around the finger of a patient and exposing it to cold; in healthy persons this procedure does not alter the composition of blood, but in patients suffering from paroxysmal hemoglobinuria the blood drawn from a finger treated in this way will be disintegrated, the blood-corpuscles will be broken up, and the hemoglobin dissolved in the serum, which therefore has a pink instead of a yellowish color.

Late investigations of paroxysmal hemoglobinuria have shown that this condition is always associated with hemoglobinemia and the latter with a

hemoclastic crisis. Syphilis is the necessary and sufficient cause, cold being only a casual factor. Syphilitics are predisposed to hemolysis. In a case in a woman of 27, in whom cold always brought on the symptoms, relief was obtained with mercury and arsphenamin, the Wassermann simultaneously becoming negative. Montagnini (*Presse méd.*, Dec. 24, 1921).

Case of hemoglobinuria followed by nephritis in a man treated for syphilis with neoarsphenamin and bismuth. There were generalized muscular spasms, with ultimate death from uremia. Munter and Steinmetz (*Klin. Woch.*, Feb. 12, 1926).

**PATHOLOGY.—Urine.**—The urine varies in color from smoky to pink or red, sometimes almost black: the color has been compared to that of porter, coffee, or port wine. The urine is usually turbid, of variable specific gravity, and highly albuminous; it deposits after some time an abundant, chocolate-colored, grumous sediment, which microscopically is seen to consist of granular hemoglobin, mixed with renal casts (hyaline and fatty), sometimes also with crystals of hematin, uric acid, and oxalate of lime; occasionally a few blood-corpuscles may be found. The coloring matter is not hematin nor always hemoglobin, but most frequently methemoglobin.

According to E. G. Ballenger, the quantity of hemoglobin varies exactly with the severity of the attack. The color of the urine varies from a delicate rose color to a reddish brown, brownish black, or a deep black. The urine contains a distinct amount of albumin. Kidney epithelium and leukocytes are found. Bile is said to be seldom found. There is usually a decrease in the amount of urine after attacks. Hemin appears in paroxysmal hemoglobinuria, but not to such an extent as is found in the infectious forms.

As to the exact portion of the renal tubule which is responsible for the excretion of hemoglobin, the writer believes that it is the epithelium of the convoluted tubules and possibly also that of the tubes of Henle, as in sections of kidneys re-

moved within a few hours of the intravenous injection of hemoglobin the casts are found to be limited to the cortex and are not seen in the large collecting tubes of Bellini. Later, however, the plugs are found in the large collecting tubules, but in these cases they have probably simply descended from higher portions of the tubules. His observations are more in harmony with the view that hemoglobin is excreted by the renal epithelium than that it is filtered through the glomeruli, and that the amount of hemoglobin eliminated into the urine is dependent on the activity of the epithelium lining the renal tubules. Yorke (*Annals of Trop. Med. and Parasitology*, Dec. 30, 1911).

It has been found by the writers that when a relatively large amount of hemoglobin is injected intravenously, hemoglobinuria appears in a very few minutes; if a relatively small quantity be injected rapidly, it may appear with choluria; even moderately large amounts slowly injected may be eliminated without the occurrence of choluria. The absence of the spleen does not appear to affect the elimination of hemoglobin by the kidneys. The writers' idea is that hemoglobinuria does not occur until hemoglobinemia reaches the level of 0.06 Gm. per kilo body weight. When this amount is surpassed hemoglobinuria occurs, and when the concentration is less than this it ceases. The liver, however, and perhaps other tissues, take up hemoglobin as soon as it appears in the serum, and deal with it regardless of its excretion by the urine. The kidneys remove 17 to 36 per cent., and the liver takes the rest to be transformed into bile pigment. If the circulation be flooded with a large amount of hemoglobin absorbed rapidly, the bile pigments cannot be rapidly enough removed, and reabsorption into the blood occurs with the appearance of choluria. The writers would thus explain those cases in which hemolysis is accom-

panied by jaundice without hemoglobinuria; the liver removes the hemoglobin so rapidly that the minimum necessary for hemoglobinuria is not reached. Nevertheless, even under these circumstances a liver may absorb a large amount of hemoglobin, so that bile formation is so excessive that jaundice appears. As a corollary to this, a very large amount of hemoglobin appears quickly in the urine until the excess has been removed, when it no longer appears, the slow elimination of the remainder by the liver causing the subsequent choluria. Pearce, Austin, and Eisenbrey (*Jour. Exper. Med.*, Sept., 1912).

Hemoglobinuria can originate from the respiratory, digestive, or cutaneous areas, from the uterus, from wound surfaces, and from the blood itself. It may be due to burns, cold, overexertion, poisons, hemorrhage, pregnancy, and infections. The elimination of hemoglobin is effected by the convoluted tubes, not by the glomeruli. The lesions which appear in the kidneys are purely degenerative, not inflammatory. The jaundice which accompanies hemoglobinuria is an absorption icterus. There is no hematogenous icterus. Miller (*Berl. klin. Woch.*, Sept. 30, 1912).

**Blood.**—Recent investigations tend to demonstrate the presence of a potential hemolytic toxin (hemolysin), composed of an amboceptor and complement. The complement is a normal constituent of blood-serum, while the amboceptor is the specific hemolysin. The combined action of this dual toxin on the red cells is dependent upon certain conditions, one of which is a variation of the temperature of the blood. Exposure to cold favors the union of the amboceptor to the red cells; these when carried to the internal parts of the body, where the temperature of the blood is higher, are acted upon by the complement, and hemolysis takes place, first producing hemoglobinemia and then hemoglobinuria. It is essential that the blood be first chilled and then subsequently warmed to produce hemolysis.

During the attack the number of the red corpuscles in the blood is decreased, but afterward many small red corpuscles and hematoblasts appear and the number of red corpuscles rapidly becomes normal.

Donath and Landsteiner showed that the blood-serum of persons suffering with paroxysmal hemoglobinuria contains, during the attack, a substance which unites with the red blood-corpuscles at low temperatures and on subsequent heating to 37° C. (98.6° F.) in contact with normal serum causes their hemolysis. These observations have been confirmed by others. The hemolysins in the serum which act on the subject's own red corpuscles and are responsible for the hemoglobinuria have been termed *autohemolysins*. These are not present in health.

The experiments of Donath and Landsteiner showed that the red cells of persons with paroxysmal hemoglobinuria do not differ from normal red cells, but that the serum contains a complex hemolysin consisting of a thermolabile component and a thermostabile amboceptor. At 56° C. the complement is destroyed and the lysin becomes inactive, but the lysin can be reactivated by the addition of any kind of complement. Hemolysis occurs when the diseased blood is exposed for a short time to cold. This occurs *in vitro* as well as *in vivo*. Hemoglobinuria is frequently brought on by a cold foot-bath. The accompanying symptoms are chills, rise of temperature, swelling of the liver and spleen, often pain in the limbs and inguinal and kidney regions, sometimes with swelling of the legs and cyanosis of the ears. There is extreme vasomotor irritability. During the attack the blood-pressure is increased. Often there are also leukocytosis and a relative decrease of the small lymphocytes and eosinophiles. In an unusually severe case seen by the writer, there were high fever, vomiting, jaundice, bronchitis and in 1 of the paroxysms, hematemesis lasting 4 days. S. Földes (Jahrb. f. Kind., Apr., 1924).

An epidemic rigidity of the muscles with hemoglobinuria having been observed among the fishermen of the

Haff, L. Lewin reached the conclusion that it was due to poisoning with a volatile arsenical compound. The author endorses Lewin's hypothesis. Two cellulose factories had been using Spanish pyrite containing much arsenic. The water of the river Nogat having been diverted to regulate another river, the waters of the Haff stagnated. Comparatively large amounts of arsenic were found in the water and sediments of the Haff and in the urine and organs of the patients. Schnabel injected 1 c.c. of the filtered water into himself and into one of the convalescents. It produced a typical attack. O. Lentz (Med. Klin., Jan. 4, 1925).

Case of *paralytic* paroxysmal hemoglobinuria, added to the 3 previously recorded. There were 6 sudden attacks of hemoglobinuria with muscular pains or tenderness, pronounced weakness of the extremities and total or partial loss of reflexes. Predisposition as well as intense exertion may be factors in the condition, which the author attributes to an intoxication, with retention of toxic products in the muscles and impaired elimination by the liver, which underwent rapid enlargement. Urinary elimination of muscle hemoglobin rather than hemoglobin from the red blood cells is indicated by the absence of hemoglobinemia. From the effects of the circulating toxic material there were kidney changes, insomnia and restlessness, and muscular degeneration, including myocardial involvement. Hittnair (Wien. klin. Woch., Apr. 16, 1925).

Case of paroxysmal hemoglobinuria peculiar in that a hemoclastic crisis preceded the attacks. The autohemolysin showed its hemolytic action *in vitro* even without any chilling. Apparently the attacks of hemoglobinuria occurred only at night in this patient. Enneking (Nederl. Tijd. v. Gen., Oct. 3, 1925).

The writers report 2 cases and conclude that the hemoglobinemia which follows exposure to cold is due to some biological product in the plasma which in its behavior admits of the demonstration of every step in

hemolysis as expounded by the side-chain theory of Ehrlich. Hoover and Stone (*Arch. of Internal Med.*, Nov., 1908).

In a study of 4 cases of paroxysmal hemoglobinuria, confirming the work of Donath and Landsteiner, and Hoover and Stone, the writers demonstrated the autohemolysin described by Donath and Landsteiner in all of their cases. In some instances this has been missed by other observers, but the authors find that these negative results are probably due to the fact that often, and especially after a paroxysm, the complement is largely, if not quite, exhausted in the patient's blood. Hemolysis may, however, always be obtained by adding fresh complement. Local lowering of temperature leads to the formation of new complement in the body, probably locally, so that one attack does not prevent an early recurrence of the attack. A few days after a paroxysm the blood contains the normal amount of complement. During the paroxysm both systolic and diastolic blood-pressures rise, even before the chill, to decline with the height of the fever. Between attacks there is a lymphocytosis of from 30 to 35 per cent. During an attack the lymphocytes are diminished to 9 or 10 per cent., the decrease being parallel to the severity of the attack; at the same time the eosinophiles diminish or disappear from the blood. The dissolved hemoglobin is excreted partly as urobilinogen. The hemolytic amboceptor is bound to the red blood-cells during cooling; it can be separated from them by repeated washing with warm normal saline solution. The red blood-cells of patients with this disease are less resistant to changes in temperature and to dilute acid and dilute saponin solutions than those of a normal individual. Toward cold alone they are not more sensitive. Against the patient's hemolysin, however, his own red blood-cells are more resistant than normal red corpuscles, which are usually aggluti-

nated by the patient's serum. The serum of the hemoglobinuric possesses hemopsonins, since it causes normal macrophages to phagocytize red blood-cells. Meyer and Emerich (*Deut. Archiv f. klin. Woch.*, Bd. xcvi, S. 287, 1909).

Report of a case of paroxysmal hemoglobinuria in a man of 48. Hemolysins were found in the blood, and their presence in the blood accumulating in the viscera in consequence of the exposure to cold, with the local accumulation there likewise of carbon dioxide in the blood, produce conditions similar to those of Hyman's test-tube experiments. Hemolysis follows and the hemoglobinuria results; the whole process can be broken up by putting an end to the action of cold by warming the legs. The Wassermann reaction was positive in this patient, which possibly throws light on the unusual lack of resistance to carbon dioxide on the part of the red corpuscles. Krokiewicz (*Wiener klin. Woch.*, April 6, 1911).

The serum of patients suffering from paroxysmal hemoglobinuria was found by the writer to contain a complex hemolysin, of amboceptor-complement nature, which is capable of bringing about the solution of the patient's own corpuscles, corpuscles of other paroxysmal hemoglobinuric patients, and of all other individuals, as far as tested. Patients suffering from paroxysmal hemoglobinuria are not confined to one group, as determined by the isoagglutination reaction, and their serum may contain normal isohemolysin in addition to the hemolysin characteristic of their disease. The autoamboceptor may be absorbed from patient's serum, leaving the isoamboceptor, and conversely the isoamboceptor may be absorbed, leaving the autoamboceptor, thus enabling each to be tested separately on any given set of corpuscles. Only the amboceptor component of the hemolysin of paroxysmal hemoglobinuria is peculiar to the disease. The complement differs in no way, so far

as tested, from that present in normal serum. The amboceptor peculiar to paroxysmal hemoglobinuria differs from other known hemolytic amboceptors in that it will unite with the red blood-corpuscles only at a low temperature in the presence of complement, and, furthermore, in that it is capable of bringing about the solution of the patient's own cells (autohemolytic action) and those of other members of the group to which the patient belongs, as well as the cells of members of other groups. Hemolysis due to the autohemolysin of paroxysmal hemoglobinuria, unlike normal isohemolysis, may occur entirely independently of agglutination. The red cells of 3 patients showed a variable and usually increased resistance to hypotonic salt solution, never a resistance less than that of normal corpuscles. All 3 cases gave a positive Wassermann reaction. Moss (Bull. Johns Hopkins Hosp., July, 1911).

In his experiments the author noticed that the corpuscles of patients suffering from paroxysmal hemoglobinuria were somewhat less resistant to an atmosphere of carbonic acid gas, as compared with corpuscles from a normal individual. This difference was not very marked, however. The chief difference lay in the blood-serum of the patient.

Contrary to the findings of Hyman, it was found that normal corpuscles in normal salt-water suspension were also, although more slowly, hemolyzed in an atmosphere of carbonic acid gas. Sodium citrate solution, strength 1.5 per cent., was sufficient to prevent hemolysis of both the patient's and normal human corpuscles in an atmosphere of carbonic acid gas at room temperature. Apparently the salt concentration of the blood-serum is the factor which determines whether the corpuscles shall be hemolyzed or not. Normal serum has sufficient salt dissolved to prevent hemolysis of both the patient's and normal corpuscles in an atmosphere of CO<sub>2</sub> at room tempera-

ture. The paroxysmal attacks have been variously ascribed to the action of cold, congestion, and trauma, locally or remotely produced. It would appear that local changes in the tissues must be necessary before a state of hemoglobinemia or hemoglobinuria can be produced. In view of the fact that cold, trauma, and passive congestion may all lead to an attack, and since the three conditions are associated with the production of an excessive acidity of the tissues, it is not unreasonable to suppose that the organic acids thus formed play some part directly in the production of the attacks. The corpuscles may be less resistant, they may be subject to the action of a specific hemolysin, and yet an additional factor acting locally in the tissues seems necessary for an attack to be produced. In the presence of the proper salt concentration, the corpuscles are protected against the hemolytic action of any organic acids. This naturally suggests the giving of neutral salts as a therapeutic agent, to prevent the onset of attacks in patients suffering from paroxysmal hemoglobinuria. O. Berghausen (Jour. Amer. Med. Assoc., from Arch. of Internal Med., Feb., 1912).

In 11 cases of paroxysmal hemoglobinuria observed by the writer, serologically, all exhibited autohemolysis after the original method of Donath and Landsteiner, though in some instances complement was exhausted, and it was necessary to add it before hemolysis occurred. The autohemolysis was less pronounced the oftener the attacks of hemoglobinuria. Variation in the autohemolysis was dependent not only upon differences in the quantity of complement, but also of autohemolysin. In 45 per cent. of his cases, the writer demonstrated isohemolysins in the blood. Usually, the red blood-corpuscles of a hemoglobinuric whose blood contains isolysins are protected from the action of the isolysins of a second patient. J. Matsuo (Deut. Archiv f. klin. Med., Bd. cvii, S. 335, 1912).

The paroxysms have in some cases been ascribed to the presence of parasites in the blood; in animals (oxen, horses) a similar disease has been observed. Krogus and von Hellens found in the blood of diseased oxen parasitic corpuscles analogous to the plasmodium of malaria.

Discussing the paroxysmal hemoglobinuria of horses and cattle as well as man, the writer deems it likely that in horses functional liver disorder promoted by calcium deficiency in the fodder or a chill may lead to deficient catalase production. The acute degeneration occurring in the horse's muscles of progression in conjunction with the paroxysm of hemoglobinuria is explained as arising from exhaustion of catalase, with consequent deficient oxidation and accumulation of lactic acid. Proteolytic enzymes are at the same time set free and their activity, previously inhibited, is no longer restrained; autolysis is the result and hemolysis accompanies it. In the typical paroxysmal hemoglobinuria of man, which follows chilling, the hemolysis occurs directly in the chilled blood, not in the internal organs at a later time. The hemolysin theory, at present accredited in man, is inapplicable to the equine disease. C. E. Corlette (Med. Jour. of Australia, May 3, 1924).

**DIAGNOSIS.**—The presence in the urine of hemoglobin, or more correctly of methemoglobin, may be demonstrated by different tests, as Heller's test, the guaiac test, the microscopic examination, and spectral analysis (see HEMATURIA). By spectral analysis two absorption bands are found between *D* and *E*, and a third between *C* and *D*, of the Fraunhofer lines.

Several methods for the *serum diagnosis* of paroxysmal hemoglobinuria are described by Kolmer as follows:

(I) In Ehrlich's procedure, a small tourniquet is applied about the base of one of the patient's fingers, and the finger is kept in ice water for  $\frac{1}{2}$  hour. Blood from the finger thus constricted is now collected in a Wright capsule, and blood from a finger of the other hand obtained as control. Both blood samples are allowed to clot and

then centrifugated. The serum from the finger held in ice water is tinged red, in a positive test, with the dissolved hemoglobin, whereas the control serum is not at all or less deeply tinged.

(II) The same method carried out *in vitro*, as employed by Donath and Landsteiner. Blood is collected in a small test-tube, cooled to 0° C. for  $\frac{1}{2}$  hour, then heated to 37° C. for 3 hours. The presence or absence of hemolysis is observed, and the results compared with those obtained with normal blood similarly treated at the same time.

(III) Pipet 2 c.c. of the patient's blood in a small test-tube and separate the serum. At the same time place 1 c.c. of blood in a centrifuge tube containing 9 c.c. of a 1 per cent. solution of sodium citrate in normal salt solution. Wash the corpuscles twice and suspend the sediment in 10 c.c. of normal salt solution. Then, secure 1 c.c. of fresh serum from a normal person. Make the following mixtures:

Tube 1: 0.2 c.c. patient's serum + 1 c.c. corpuscle suspension.

Tube 2: 0.1 c.c. patient's serum + 1 c.c. corpuscle suspension.

Tube 3: 0.2 c.c. normal serum + 1 c.c. corpuscle suspension.

Tube 4: 0.1 c.c. normal serum + 1 c.c. corpuscle suspension.

Tube 5: 1.0 c.c. corpuscle suspension.

Add sufficient salt solution to each tube to make 2 c.c. Shake gently and place in refrigerator (not above 4° C.) for 1 hour. Shake gently and incubate at 37° C. for 2 hours. The tubes are then centrifugated and the presence or absence of hemolysis noted. Usually the patient's serum shows hemolysis of greater or less degree.

The Donath-Landsteiner test can be performed microscopically as well as macroscopically. The blood is run into a flask of citrate solution at 39° C. If a little serum is added to the washed corpuscles on a slide, a rapid agglutination of the corpuscles is seen. If, however, the corpuscles and serum are cooled before and during the mixing, agglutination does not occur but, instead, most of the corpuscles arrange themselves in rouleaux, though some remain free, the more the greater the

cooling. Upon warming the mixture now to 37° C., the isolated corpuscles give up their hemoglobin and become shadow corpuscles, while the corpuscles constituting the rouleaux remain intact. A. Nyfeldt (Ugeskr. f. Læger, Jan. 15, 1925).

**PROGNOSIS.**—In the hemoglobinuria caused by poisons, infectious diseases, septic diseases, etc., the prognosis is determined by the gravity of the primary disease; intermittent hemoglobinuria is for a long time compatible with life; the patients never die during an attack; recovery has been observed, but often the disease continues for many years.

**TREATMENT.**—When hemoglobinuria is a symptom the treatment must be directed toward the fundamental disease; in cases connected with syphilis, **anti-syphilitic treatment** has been of use, as well as **quinine** in hemoglobinuria of malarial origin.

In paroxysmal hemoglobinuria **change of climate, dietetic treatment, iron, quinine, and arsenic** have been recommended.

In 9 severe cases of hemoglobinuric fever in chronic malaria, the writer employed the following treatment: Subcutaneous injection of **salt solution** every six hours, with the same by rectum twice a day; **wet cupping** to the lumbar region; from 5 to 8 Gm. (1¼ to 2 drams) of **calcium chloride** during the day; restricted to a **milk diet**, and complete **abstention from alcoholic drinks**. The patient was kept in a **warm bed**. If hematozoa are found in the blood, or if paroxysms recur, he gives 1 Gm. (15 grains) of **methylene blue** a day, in four doses, keeping this up for ten days, and then commencing cautiously with **quinine**, 0.1 Gm. (1½ grains) every two or three days. If no fever follows this the dose is gradually increased until the patient is taking 1 Gm. or 1.25 Gm. (15 to 19 grains) of **quinine** a day. This is kept up for several days, when the patient is not only cured of his hemoglobinuric fever, but also of malaria. Cardamatis (Jour. Amer. Med. Assoc., from Grèce méd., vol. viii, Nos. 17-20, 1907).

The *prophylaxis* consists chiefly in **avoiding exposure to cold** and in acquiring an immunity to its effect by suitable hardening measures. When possible the patient should live in a **warm climate** and wear **flannels** during chilly weather. Use of food containing oxalic acid was forbidden by Robin on account of the frequent excessive secretion of calcium oxalate. **Tonics, iron, and a nourishing diet** are necessary when the patient is anemic and weak. E. G. Ballenger (N. Y. Med. Jour., July 11, 1908).

As **cholesterin** seems to have an inhibiting action on hemolysis in the test-tube, the writer applied it to arrest paroxysmal hemoglobinuria and found that it did actually abort the attacks and ward them off as long as the system was under the influence of the cholesterin. On its suspension the attacks recurred as before. He gave the cholesterin in five intramuscular injections of 5 c.c. (1¼ dram), each time of a 10 per cent. emulsion of cholesterin, in the course of eleven days. Pringsheim (Med. Klinik, Feb. 16, 1913).

The writer was led to use a drug exerting a conserving, reparative influence on the red blood cells, *viz.*, **arsenic**, in intravenous injections. In the first five patients thus treated—three already in a grave condition—two injections cleared up the urine and caused prompt convalescence. Subsequently the following combination was used: **Colloidal arsenic**, 0.00034 Gm. (½<sub>200</sub> grain); **colloidal iron**, 0.00012 Gm. (½<sub>600</sub> grain), and **water**, 2 Gm. (30 grains). Twenty-three patients received such injections, without any other treatment. The combined series showed 28 cases with 1 death, or 3.57 per cent., as against the usual mortality of 33 per cent. The single unfavorable case was that of a little girl of 8 years in whom no intravenous injection could be given, and who received only intramuscular injections, which are ineffectual. As soon as fever and hemoglobinuria appear in a malarial patient, an injection of iron and arsenic



**collobiase** should be given, followed by another injection the next morning. The urine now generally clears up, but for safety a third and last injection is given. Beginning the fourth or fifth day, **adrenalin** is administered for about a week. During convalescence, malarial paroxysms sometimes appear. These are satisfactorily overcome by intravenous injections of quinine **collobiase**. R. Roux (*Presse méd.*, July 25, 1918).

In a case in a man of 27 years with hypothyroid stigmata and of syphilitic parentage, the author obtained no results from antisyphilitic treatment, but the hemoglobinuric attacks disappeared under **thyroid gland**, increased in a month from 0.025 Gm. ( $\frac{3}{8}$  grain) to 0.2 Gm. (3 grains) a day. In 3 cases Vidal decreased the attacks by continued **autoserotherapy**. Pareja (*An. de la Fac. de med.*, Montevideo, Apr., 1921).

Regarding hemoglobinuric or black-water fever, B. C. Ray (*Calcutta Med. Jour.*, Sept., 1922) states that neither malaria nor quinine alone can produce hemolysis, and that the third necessary factor is acidemia. The malarial toxin has an affinity for the liver, which regulates acid by-products. The rational treatment, he maintains, is to **alkalinize the urine** and follow this with quinine. R. Beck (*Münch. med. Woch.*, Sept. 22, 1922).

Report of 22 cases of black-water fever in which Matko's method of injecting intravenously 120 c.c. (4 ounces) of a 6 per cent. solution of equal amounts of **sodium chloride** and **disodium phosphate** during the attacks was applied. The patients usually recovered in a few days.

Intravenous injection of 6.5 to 7 per cent. **acacia** solution in 0.9 per cent. **salt** solution has the property of restoring the renal function in black-water fever, probably by raising the blood-pressure. Sir W. M. Bayliss (*Lancet*, Mar. 17, 1923).

In a congenitally syphilitic girl subject to paroxysmal hemoglobinuria the writer brought about gradual **desensitization** thus: The tip of 1 finger was

immersed in ice water for 30 seconds. As even this was followed by a leukopenia indicating a state of shock, and by a positive Weber's test in the urine, the immersion was shortened to 10 seconds, then gradually lengthened. Later the area exposed to the ice water was also increased. In 3 months the patient was freed of her sensitiveness to cold, though Donath and Landsteiner's test with her own corpuscles was still positive. Antisyphilitic treatment had been withheld during the desensitization. A. Ricaldoni (*Bull. Soc. méd. des hôp. de Paris*, July 3, 1924).

Case of paroxysmal hemoglobinuria with the usual reaction to cold. Calcium chloride failed. Vidal's treatment was then tried: On alternate days, in amounts ascending from 20 to 60 c.c. ( $\frac{2}{3}$  to 2 ounces), the patient's **own serum** was injected intravenously, to a total of 10 injections. Rosenbach's test of bringing on an attack by immersion of the hands in water at 10° C. (50° F.) for 15 or 20 minutes thereupon became negative and the Donath-Landsteiner test was not so strong as before. The patient had but 1 attack in the succeeding 2 years. A. Nyfeldt (*Ugeskr. f. Laeger*, Jan. 15, 1925).

L. and W.

**HEMOPERICARDIUM.** See HEART AND PERICARDIUM, DISEASES OF.

**HEMOPHILIA.—DEFINITION.**—Hemophilia is an inherited or acquired disorder of the blood, characterized by an abnormal liability to severe and sometimes uncontrollable hemorrhages.

**SYMPTOMS.**—The condition is generally discovered by accident, a slight wound, the extraction of a tooth, the application of a leech, vaccination, etc., being followed by profuse and sometimes dangerous bleeding. Epistaxis is of frequent occurrence. In 334 cases collected by Grandidier from the literature, it was the leading symptom in 169 instances.

In women epistaxis is especially common, because the hemophilic process mainly manifests itself through the mucous membranes; menorrhagia, metrorrhagia, post-partum hemorrhage, etc., are also frequently suffered from. According to Kolster, however, pregnancy and labor do not present the danger for an hemophilic woman that might be supposed. Of 130 cases, the death of the mother occurred only in 3 and abortion in only 16 cases.

Again, it does not seem to interfere with normal development. Comby refers to the case of a girl aged 11 months in whom from the third week of life there had been continuous and spontaneous hemorrhages from the nose, mouth, and rectum, and into the substance of the skin, without, however, impairing in any manifest way the child's development.

It may simulate purpura. The skin may be the seat of hemorrhage-forming dermatomata or ecchymoses in circumscribed areas. This is especially the case after a pinch, a blow, etc., or they may occur without provocation. Eruptive fevers, especially scarlatina and varicella, may provoke them.

#### **Hereditary Hemorrhagic Thrombasthenia.**

—This condition has been described by Glanzmann as a disorder differing from hemophilia essentially in that the blood clots are not retractile, whereas in hemophilia retractility is held to be normal. As stated by F. van der Zande (Ned. Tijd. v. Gen., Feb. 10, 1923), who prefers for the disorder, however, the term *pseudo-hemophilia*, the condition is closely related to purpura hemorrhagica and is due primarily to functional insufficiency of the bone marrow. Males and females are equally affected. The blood clots rapidly, but the clot is not firm, as in hemophilia. Differentiation of hemophilia from thromb-

asthenia is difficult only if the bone marrow has been exhausted by repeated hemorrhages, in which event the platelets may be diminished and the clot subnormal in retractility; the presence of anemia and leukopenia, however, usually permits of distinction of hemophilia from thrombasthenia. In a thrombasthenic family seen by van der Zande, the platelets showed some morphologic change and the bleeding-time was prolonged, though the clotting time was normal.

There frequently occurs in hemophiles a sanguineous infiltration in the iliac fossa, particularly in the sheath of the psoas iliacus, which has produced symptoms that have led to an operation for a suspected appendicitis. It can occur, however, in other than hemophilic subjects. In operating, the writer has found, for instance, an appendix separated from the cecum, the artery having ruptured and caused the blood-tumor. Schwartz (Paris Méd., Oct. 12, 1912).

The hemorrhages may be internal, considerable blood being evacuated from the intestinal canal, the bladder, etc., and hemophilia may cause cerebral hemorrhage by producing extravasations, though it is probable that in these cases there also exists a concomitant vascular disease. Slight local trauma may be sufficient to induce apoplexy in a hemophilic (Hauck). Reddish striae representing minute dilated vessels are sometimes noted on the skin.

Hemorrhages into the joints and periarticular tissues are common. In men arthritic symptoms are frequently observed, especially during cold and damp weather, the knees being most prone to pseudorheumatic manifestations, which are sometimes accompanied by fever. The joint symptoms are often the precursors of an approaching hemorrhage. They may be attended with swelling of the joint and pain, and give rise to fever.

Hemophilic diseases of the joints may be divided into two classes: the spontaneous and those caused by a violent effort. The spontaneous is the only true form of hemophilic joint disease; in the other the joint manifestations may be present in normal individuals, but greatly aggravated when the hemorrhagic diathesis is present. It differs from the other form: 1. In the cause; in the spontaneous appearance, without any, or only a slight, traumatism, or a long walk, in the other following a serious injury. 2. In the time of its appearance, coming on slowly, five or six hours after the walk or slight effort in the former, immediately in the latter. 3. In the acuteness of the symptoms, which are moderate in intensity in the spontaneous, but considerable in the other form. 4. In the duration of the acute period, which is generally about eight days, rarely more than fifteen, in the spontaneous, and from fifteen to eighteen in the traumatic. 5. In the course and result, *restitutio ad integrum* being the rule in the spontaneous cases, except in the chronic form, while pseudo-ankylosis is apt to persist in the traumatic cases. Cruet (*Presse méd.*, Sept. 9, 1908).

Arthropathies may be classified as (1) simple hemarthrosis; (2) subacute arthritis, or (3) chronic arthritis. The first appears rather suddenly. The joint is swollen and tender and is immobilized in semiflexion. There is a local rise of temperature as well as constitutional,  $38^{\circ}$  to  $39^{\circ}$  C. ( $100.4^{\circ}$  to  $102.2^{\circ}$  F.). There is fluctuation, and exploratory puncture shows a sanguineous exudate. The X-ray shows normal articular surfaces. The course is seven to eight days. This condition is not infrequently followed by muscular atrophy. The second and third are accompanied by atrophy of the muscles, are painful, and leave the joints in a damaged condition. Another not infrequent symptom is hematoma in the psoas muscle. The onset is sudden and painful. The leg is held in

outward rotation, flexion, and abduction. Tumefaction in Scarpa's triangle, sensory disturbances, and paralysis of the quadriceps occur if the crural nerve is compressed. The diagnosis can only be affirmed by examination of the blood. Gullain (*La Clinique*, June 2, 1911).

Three stages of joint troubles are observed in hemophilia: (1) of hemarthrosis; (2) inflammation, and (3) stage of retrogressive changes with deformity. The painless, sudden onset in pale young men marks the first stage. Hemorrhages in the skin complete the diagnosis. The second stage is strikingly similar to the white swelling of tuberculous arthritis, and has led to mistaken diagnosis, 2 of 3 cases observed by Koenig having suffered death in consequence, from hemorrhage after operation.

Hemorrhages from mucous membranes may be so profuse and prolonged as to prove fatal. When they can be arrested, recovery is, as a rule, prompt when the loss of blood has not been too severe; otherwise anemia may persist. Recurrent epistaxis should always awaken suspicion; the capillaries ooze blood.

The tourniquet sign of disease with hemorrhagic manifestations is an aid to ascertain whether hemophilia is present. A constricting band is applied to the limb above, not drawn tightly enough to induce actual arterial hyperemia, but merely enough to cause the veins to be a little more prominent. Any tendency to a hemorrhagic diathesis is then rendered locally evident. The disease does not seem to be with the blood itself so much as in the walls of the vessels. In some of their patients a slight traumatism at one point was followed by hemorrhagic manifestations all over the body except the face, and no means could be devised to induce them in the face; evidently

the vessel walls here are exceptionally strong. C. Frugoni and F. Giugni (*Semaine méd.*, Jan. 18, 1911).

While the leucocytes may be considerably increased, the predominating characteristic of the blood is the relative length of time it takes to coagulate when drawn. Instead of the normal five to six minutes, the coagulation time may be extended many minutes and even hours.

**ETIOLOGY AND PATHO-GENESIS.**—The prevailing belief that the tendency to hemophilia is transmitted through the female line only (Nasse's law) cannot be said to be universal, though nearly so, Kolster having shown that there were exceptions. Hoessli refers to a family in Switzerland in which hemophilia can be traced back three centuries. While it included male bleeders, the females, as a rule, remained exempt, but they transmitted the disease to their male offspring.

History of a family of hemophiliacs in which the disease was traced back four generations. The transmission had in every case been through the female. W. M. McCabe (*So. Med. Jour.*, Dec., 1909).

Study of hereditary hemophilia under conditions of tenure of a Carnegie Research Scholarship. Twelve patients were examined descended from 6 different hemophilic stocks in Scotland, England, and Germany. In none of these families had there been any known instance of a departure from the characteristic type of transmission, *i.e.*, from the females to the males. The results showed that there is a delay in the coagulation of hemophilic blood, a delay which in some cases is very pronounced—over one hour in some—and which far exceeds any retardation of coagulation observed in other disease. Addis (*Quarterly Jour. of Med.*, Oct., 1910).

The writer recalls the extreme infrequency of hemophilia in the female. In the celebrated Mampel family, 4 generations of 212 individuals, there were 37 bleeders, all males. In certain individual statistics, however, 10 per cent, and even more have been of the other sex. Castex (*Med. Rec.*, Nov. 25, 1916).

The rarity of hemophilia in adults is attributed to the tendency for hemophilic children to succumb before reaching maturity and to the blood of survivors acquiring the proper power of coagulation. The patients are usually under 15 years old and of the male sex; a history of traumatism; indolence and benign nature of lesion; presence of subcutaneous hematomata; absence of adenopathy; radiographic findings and the hemophilic family history. Madero (*Rev. de la Asoc. med. Argentina*, Oct., 1917).

Such families are often large, and the disease seems to have a predilection for blondes. It is said to be more common in German countries and among Jewish people, but it has been encountered in all civilized countries, including, particularly, the United States. According to Virchow, 7 men are affected to 1 woman.

Case in which the inheritance came through the father, who was himself a bleeder. This is the first case, so far as the writer knows, of typhoid fever reported in a bleeder. It showed that such may be brought to a successful termination in a patient so afflicted. No hemorrhages occurred from the intestinal lesion. The successful termination was probably in large measure due to the fact that at or about the age of 40 the hemorrhagic tendency abated. Larned (*Amer. Jour. Med. Sci.*, March, 1910).

The cause of hemophilia, and of the characteristic slowness of the blood to coagulate, has been shown by many investigators to be due to deficiency of thrombokinase in the blood-cor-

puscles, and therefore in the blood fluids. As it is this substance which endows the blood with its power to coagulate, this property is compromised in proportion as the deficiency of thrombokinese is marked. Hemorrhages do not cease, as in normal individuals, because the formation of the clot is thus prevented.

[In 1907 I ascribed the coagulating power of the blood mainly to the adrenal secretion, which I held penetrated the red corpuscles in the lungs. Thrombokinese, since found to be contained in the same corpuscles, is probably the adrenal product which I then termed "adrenoxidase." S.]

Howell states that in normal individuals the cellular elements of the blood and the wounded tissue produce thrombokinese, that thrombokinese + calcium + thrombogen form thrombin, and that the union of thrombin and fibrinogen forms fibrin.

According to Sahli, the coagulation of hemophilic blood is increased by the addition of defibrinated blood which has been rendered fibrin-ferment-free by heating to 60° to 62° for half an hour. (This points to thrombokinese—not thrombogen—as the substance which is decreased in hemophilic blood. Normal blood-serum, after removal of fibrin ferment by heat, also accelerates the coagulation of hemophilic blood, though less strongly, indicating that thrombokinese is normally to a certain extent excreted by the corpuscles into the serum during coagulation. Normal corpuscles washed ferment-free strongly increased the coagulability when added to hemophilic blood, while similarly prepared hemophilic corpuscles produced a like but very slight effect.

The writers were impressed with the essential rôle of the platelets in 2 cases. Whereas addition of normal platelets to hemophilic plasma caused it to coagulate in normal time, hemophilic platelets, added in amounts 75 times as large, never reduced the coagulation to anywhere near normal. The delay in coagulation in hemo-

philia, occurs in the initial step in clotting, which seems to be a rendering of the platelets available by some process resembling solution. Minot and Lee (*Arch. of Internal Med.*, Oct., 1916).

Hemophilia may be neither hereditary nor even familial. The coagulation time is increased, but a similar anomaly may occur in various liver affections, and the bleeding time may be quite normal, even when the coagulation time is prolonged. In view of the uncertainty of such tests in the diagnosis of hemophilia, the writer devised a new, more conclusive method: Capillary tubes 10 cm. (4 inches) long are filled directly with blood flowing from a needle introduced into a vein, and kept in a moist chamber. Every 5 minutes a tube is taken out and the blood blown out of it with an instrument which records the pressure required for this purpose. For the first 10 to 15 minutes no appreciable pressure is needed with normal blood, but after this time the resistance of the clot increases until the 20th or 30th minute, when a pressure of 30 to 40 cm. of water may be needed to expel it. Hemophilia is the only disorder showing marked abnormality with this test even when the bleeding and coagulation times are normal. Thus, in a typical case the clot showed no resistance up to 2 hours, and after 3 hours only 1 cm. of water was required for expulsion. The blood of normal pregnant women possesses a power of coagulation 10 times as great as normal, as measured by the resistance of the clot; from this standpoint pregnancy constitutes the extreme opposite of hemophilia. K. Hynek (*Ann. de méd.*, Aug., 1923).

Two cases, a boy and a girl in the same family, in which the current theories of hemophilia failed to explain the conditions present. In neither child was there prolongation of coagulation time, though repeated tests were made. In both cases vein puncture was innocuous, not even producing ecchymosis, whereas capillary puncture produced extravasation and hemor-

rhage. Arrest of the blood upon puncture of the girl's ear lobe took  $\frac{3}{4}$  hour. The authors regard hemophilia as due to inability of the capillary walls to contract, owing to some functional influence. The arrest of capillary hemorrhage is determined, not by thrombosis, but by contraction of the capillary walls. Cavenot and Grinda (*Ped. españ.*, Feb. 29, 1924).

In 3 boy bleeders, 2 from the same family, the cupping glass caused many fine cutaneous hemorrhages, indicating that the vessels were very easily ruptured. The fibrinogen content of the blood was at least normal. There was normal or even shortened bleeding time. Resistance of the erythrocytes was increased. The blood of the 3 mothers showed normal coagulation time but lengthened bleeding time, bleeding from the ball of the finger continuing 4 hours. All 3 women had very copious hemorrhages during menstruation and postpartum.

Zak is quoted as attributing importance to the lipoids in coagulation and believing the theory of thrombokinasase superfluous. According to the authors' experiments the cause of the disturbed coagulation is not an insufficiency of one or the other coagulating factor, but an insufficiency of some substance which "unlocks" cell function in general. Whether this substance is endocrin—as has been suspected because females are spared,—or whether inferiority of a whole cell system plays a rôle, cannot now be said; the latter hypothesis seems more likely in view of late researches on heredity. H. Opitz and H. Zweig (*Jahrb. f. Kind.*, Oct., 1924).

Experiments indicating that the prolonged coagulation time in hemophilia is due to prolongation of the time of the change of the proserozyme to serozyme (thrombogen). This may be due to the presence of some stabilizer of the proferment. In treatment, the normal serozyme is supplied by transfusion of normal blood, which is therefore the most logical measure. Feissly (*Klin. Woch.*, Apr. 30, 1925).

In a hemophilic family studied, there were 14 proved cases of hemophilia in 8 generations. There were no cases in females and no transmission through males. The coagulation time and prothrombin time were from twice to 25 times as long as normal. The finding by Minot and Lee of a qualitative platelet deficiency without a diminution in the number of platelets was confirmed. The bleeding time, capillary resistance, nature of blood clot when finally formed, amount of blood calcium and number of blood platelets were at all times found normal in these cases. In a case of sporadic hemophilia the clinical picture and blood abnormalities were the same. Davidson and McQuarrie (*Johns Hopk. Hosp. Bull.*, May, 1925).

Hemophilia has been ascribed to a deficiency of calcium salts, but it has been shown by Addis that variations in the percentage of calcium have but little influence on the coagulation time, and the clinical use of calcium has not proved of much value.

**PATHOLOGY.**—Lesions have also been found in the vascular walls, affecting especially the middle or muscular layer. According to Kuhlmann, the changes are such as to seriously compromise the anatomical and physiological functions, but it is possible that these are, in most cases, due to concomitant diseases, the lesions corresponding with the coagulation necrosis of tuberculosis, syphilis, and other general disorders.

**PROGNOSIS.**—Hemophilia is particularly to be feared when it occurs in children in an aggravated form. Through modern methods of treatment, however, its baneful effects may, when the disorder is discovered early, be forestalled in most instances. In slight cases the disease frequently disappears at puberty. The hemorrhages are usually more

dangerous in boys than in girls; uterine hemorrhages, though copious, seldom endanger life.

**TREATMENT.**—The **prophylactic treatment** of hemophilia consists mainly in the avoidance of exciting factors. The extraction of teeth should especially be shunned and preference may be given to other measures, such as gradual loosening and eviction with rubber, of a tooth, rather than to the forceps. Scratches, cuts, etc., should be avoided; hence an occupation exposing the sufferer to solutions of continuity becomes dangerous. Violent exercise is occasionally the only exciting factor.

Inasmuch as the daughter of a bleeder transmits hemophilia to her sons, while her daughters, though themselves not bleeders, transmit the disease to their sons, females who belong to hemophilic families and males who suffer from the disease should not marry. As a rule, severe cases of hemophilia—which usually begins about the second year—do not survive childhood.

**Hydrastis canadensis** has seemed useful as a prophylactic, but only in large doses, 10 to 15 drops of the fluidextract three times a day. Sir A. E. Wright recommends **thymus gland**, while Fuller, Sajous, and others have found **thyroid gland** very useful as a prophylactic. The latter is of great advantage to prepare a hemophilic patient for operation; 3 grains (0.2 Gm.) of the desiccated gland three times a day gradually raises the coagulating power of the blood sufficiently to permit even a serious operation, nephrectomy for example, as observed by W. J. Taylor.

Case in which the patient ultimately became very anemic. Finally **thyroid**

**extract** was given in doses of 5 grains (0.3 Gm.) each three times a day. The good effect was noticed at once by lessening of pain, which had hitherto been severe, and diminution in loss of blood. In eight days bleeding had ceased. Rugh (*Annals of Surg.*, May, 1907).

Case of a girl of 19 with hemorrhagic manifestations combined with mild thyroid deficiency, in which **thyroid gland** gave good results. Bottaro and Mussio (*Bull. Soc. méd. des hôp. de Paris*, Apr. 23, 1920).

Under injections of **corpus luteum** the blood in 1 case showed a coagulability even greater than normal, and hematuria ceased after the 1st injection. The effect of the injections wore off after 7 days, but improvement was again quickly obtained when they were resumed. K. Hynek (*Ann. de méd.*, Aug., 1923).

Women are protected from hemophilia, the writer believes, by some hormone. He suggests its treatment with **ovarian extract**, both to simulate the conditions existing in the female and to reduce the lack of thrombin. Hemophilia is due to a congenital infection attacking the vascular endothelium; usually this infection is syphilitic. Gonzalez Alvarez (*Siglo méd.*, Jan. 3, 1925).

The various preparations of **iron** have been recommended, including the **perchloride**, advised by Legge. **Strychnine** is probably indicated on account of the involvement of the vasomotor system.

**Saline purgatives**, by reducing the arterial tension, are serviceable in these cases when prodromic symptoms are noticed.

Case of a boy of 11 years, descended from a hemophilic family, who had a severe hemorrhage, following the loss of a milk-tooth. The alveolus was tamponed with a piece of gauze saturated with **diphtheria antitoxin** and 20 c.c. (5 drams) was administered subcutaneously. The bleeding ceased

promptly and did not recur. Broca (*Presse méd.*, No. 24, 1907).

The writer arrested threatening hemorrhages with **diphtheria antitoxin** in a hemophilic boy 4 years old. Success, however, was not complete until he had supplemented the diphtheria antitoxin with **fresh rabbit serum**. He holds that failures in the experience of others are due to the fact that the serum used was too old, or modified in some way. The injection of 10 or 20 c.c. (2½ to 5 drams) of serum should be repeated and pushed beyond the maximum generally accepted, and the fresher the serum the better the results. He injected 20 c.c. (5 drams) of antitoxin and 75 c.c. (2½ ounces) of rabbit serum in the course of eighteen days in the case reported. Gangani (*Gaz. degli Osped.*, June 15, 1909).

Case of a hemophilic mechanic who suffered from a laceration of a finger and in whom adrenalin, heat, pressure, and calcium chloride failed to control the bleeding. On the fourth day the writer injected 2000 units of **diphtheria antitoxin**, and on the next morning 2000 units more, with a stoppage of the hemorrhage within fourteen hours after the first dose. Hong (*Milwaukee Med. Jour.*, Feb., 1911).

In the treatment of **hemophilic hemorrhage** the **recumbent position** (except when the bleeding is at the nose) is of primary importance to reduce cardiac action. **Pressure** and **styptics** should then be used. **Morphine** hypodermically facilitates the action of the external remedies.

**Diphtheria antitoxin** has been found useful both as a local and subcutaneous styptic.

Of the agents so far used, however, **blood-serum**, first recommended by Weil, has been found to be the best. **Human blood-serum** is to be preferred to that of animals, owing to the fact that it does not tend to produce

anaphylaxis; 20 to 40 c.c. (5 to 10 drams) may be administered subcutaneously in the twenty-four hours. It may, in emergencies, be obtained from a willing relative or friend of the patient's. **Horse serum** or **rabbit serum** may also be used; Oliver has found the former effective when injected rectally. A piece of **fresh meat**, **squeezed over** the wound or applied to it, sometimes suffices to arrest the bleeding.

**Transfusion** sometimes becomes necessary, but it should be conducted with unusual care, owing to the morbid condition of the vascular walls. The best hemostatic is the **transfusion of entire blood**, of which but a small quantity will sometimes stop an otherwise uncontrollable hemorrhage, as long ago observed by Hayem. A few drops of **normal blood** from the nurse or surgeon sometimes suffices to arrest a bleeding wound in a hemophilic when applied to the wound. **Kneading of the tissues around the bleeding area** suffices to liberate enough thrombokinase to arrest the flow.

The writer has often obtained as high as 100 c.c. of blood from a single **rabbit**, and this furnishes about 50 c.c. of **serum**. The dose of this **serum** runs from 10 or 15 c.c. in a mild case or a very young infant to 30 or 50 c.c. in a more severe case or an older child. In severe cases this dose can be repeated at four- to six-hour intervals; in less severe cases it is given once a day for several days or until no new hemorrhages have appeared for about twenty-four hours; sometimes only one or two doses are necessary to control quite severe bleeding. W. P. Lucas (*Boston Med. and Surg. Jour.*, Nov. 18, 1909).

Analysis of the literature shows that the results of gelatin, calcium,



strontium, etc., have been disappointing, although an occasional success has been realized. In a personal case some **blood** was drawn from the child's grandmother and the traumatic wound in the left temple filled with it as a last resort. The foreign blood coagulated in the wound and the hemorrhage was arrested. K. Wirth (Centralbl. f. d. Grenzgeb. d. Med. u. Chir., Bd. xii, Nu. 7, 1909).

Locally, the writer uses gauze soaked in **horse serum** or **diphtheria antitoxin**, placed in immediate contact with the wound, after **removal of clots**. In *dental hemorrhage*, the socket must first be cleansed with plenty of saline solution before the plug soaked in serum is inserted. A *hematoma* following a wound should be opened to remove clots and the dressing then applied. In *internal hemorrhages*, serum should be injected in doses of 20 to 30 c.c., and if **human serum** is procurable, it may be given intravenously, causing almost immediate arrest of bleeding. **Calcium chloride**, 1 or 2 Gm. (15 or 30 grains) a day, may be given to promote coagulation as well as prevent serum disease. Where much blood has been lost, **rectal administration of glucose-adrenalin solution**, drop by drop, is often useful. *Pre-operative prophylaxis* in hemophiliacs consists in 20 or 30 c.c. of horse serum a day or 2 before operation; during the latter, the wounds should be plugged with serum, and a **serum dressing** later applied. Weil (Lancet, cxcix, 300, 1920).

Excellent results reported from subcutaneous injection of 20 c.c. (5 drams) of **normal horse serum** every other month. In such a case in a child of 7 years, member of a well known family of bleeders, the tendency to hemorrhage seemed completely arrested by 15 of these injections, and during the following 7 years no return of hemorrhage took place. Similar results have been obtained by the writer in 7 other cases of familial hemophilia, and he has been led to conclude that the disease is curable in this way. Weil

(Bull. Soc. méd. des hôp. de Paris, July 8, 1921).

In a case observed by the writer in a boy of 15, spontaneous rupture of the spleen necessitated **splenectomy**. After this operation no further bleeding occurred. This is the 6th case on record of a cure of hemophilia after splenectomy.

**Transfusion of blood** and serum has only a comparatively brief action, but it may improve conditions enough to render splenectomy possible. E. Wild (Mittel. a. d. Grenzgeb. d. Med. u. Chir., xxxvii, 201, 1924).

In 2 cases of hemophilia, after all ordinary measures had failed, the author succeeded in checking the bleeding with a fresh **extract of rabbit's liver**, which is rich in thrombo-kinase. Wohl (Nebr. State Med. Jour., Nov., 1925).

In children 10 to 20 c.c. of **horse serum** may be given subcutaneously or intramuscularly. If **whole human blood**, which supplies both the serum constituents and formed elements of the blood, is used, the blood may be simply collected from a vein in a 20-c.c. syringe and the entire syringe-full (as an adult dose) promptly injected into the patient's gluteal muscles without giving time for clotting. Another plan is to collect the blood in a small sterile flask with glass beads and whip the fibrin out before injection; or, the blood may be received in a sterile flask containing  $\frac{1}{10}$  the blood volume of 10 per cent. sodium citrate solution. Where blood is administered subcutaneously or intramuscularly no typing or matching of the bloods of the donor and recipient is required. If, however, restoration of blood volume exists as an additional indication on account of extensive hemorrhage, **transfusion of blood** may advantageously be resorted to.

Research on 6 typical hemophilics. The practical lessons from this work are that the hemophilia may be constantly influenced by **repeated injection of fresh human blood-serum** for the purpose of thrombokinase enrichment by the intermediate link of antikinase production. Another way is by repeated withdrawal of small amounts of blood by puncture of a vein with a fine cannula, for the similar purpose of thrombokinase enrichment, by means of the physiological reaction that follows. Experience has shown that there is no danger of hemorrhage in a hemophilic if the vein is punctured with a fine cannula, permitting harmless withdrawal of blood and the consequent physiological reaction. Sahli (*Deut. Archiv f. klin. Med.*, Bd. xcix, Nu. 5-6, 1910).

In a girl with extreme hemophilia who was treated by **rabbit serum**, the weight increased 17 pounds in five months and it was hoped that she would outgrow the tendency, but the onset of menstruation brought excessive losses of blood and, although injection of 20 c.c. (5 drams) of rabbit serum had a strikingly favorable transient effect, the child succumbed to anemia. In a second case of hemophilia, in a boy of 9, the profuse hemorrhages were arrested at once by injection of 42 c.c. (10½ drams) of fresh rabbit serum in two weeks. In both cases there was intense oral fetor some days before the onset of the hemorrhages. **The kind of serum used should be changed** at the slightest indication of anaphylaxis. Trembur (*Mitteil. a. d. Grenzgeb. der Med. u. Chir.*, Bd. xxii, Nu. 1, 1910).

The injection of **normal human serum** never gives serum sickness nor causes anaphylaxis, and the writer further believes that it is actively bactericidal, and cites its use in a case of streptococcemia in which the injection of 50 c.c. (1½ ounces) of serum apparently brought about a subsidence of the temperature and a clearing of all bacteria from the blood. Welch (*Arch. of Pediatrics*, Sept., 1910).

Case of **blood transfusion** in hemophilia, the patient being only 2½ years old. The donor was a young man aged 19. The transfusion was continued for one hour and a half and was successful, checking all oozing. Goodman (*Annals of Surg.*, Oct., 1910).

In a case of obstinate hemorrhage from a wound in a hemophilic patient the bleeding was stopped at once by a few drops of the author's **own blood** applied to the cleansed bleeding surface. J. H. Sayer (*Jour. Amer. Med. Assoc.*, Jan. 13, 1912).

The use of **serum injections, the injections of defibrinated blood, and direct transfusion** seem to have yielded better results in the treatment of hemorrhage than any other measures. Moss and Gelien (*Bull. Johns Hopkins Hosp.*, July, 1911).

The coagulation time of the blood in hemophilic subjects is greatly shortened by the injection of **fresh serum** of any species. The sera of the ox and dog should be avoided because they are more apt to produce toxic symptoms. The local application of fresh serum to wounds in patients with delayed coagulation tends to act as a hemostatic. Regular antitoxic sera are less satisfactory than freshly drawn material. The action of serum in accelerating blood coagulation is apparently due to a substitution of active thrombin. Leschier (*N. Y. Med. Jour.*, Feb. 3, 1912).

Case of a hemophilic patient who was bleeding freely from an excoriation in the corner of the mouth after extraction of a tooth. He **squeezed and kneaded the tissues around the tiny wound** in the corner of the mouth, hoping thus to flood the spot with tissue juices which he hoped might contain the thrombokinase, the substance from which the coagulation-producing thrombin is formed and which seems to be lacking in hemophilic blood. The result was an instantaneous success. When the hemorrhage recurred later two or

three times it was arrested at once each time by squeezing the region with the fingers. Having fresh goat tissue material at his disposal, the writer has been utilizing it for this purpose and commends it as the most effectual measure. Schloessmann (*Beiträge z. klin. Chir.*, Aug., 1912).

Minute clinical research in a case of hemophilia. Thrombokinase certainly lacking in the blood, but can be supplied from without by applying to the bleeding points fresh blood-serum or tissue juice. Gresser (*Zeit. f. klin. Med.*, Bd. lxxvi, Nos. 3-4, 1912).

The cutaneous or rectal injection of epinephrin, ergot, hamamelis, and calcium salts, etc., has been recommended in hemophilia, but the writer has not observed any striking result following the administration. In the case of a boy 5 years old who has been bleeding for nearly forty-eight hours from a small wound inside the lower lip caused by a fall on a fence, the injection of horse serum by the rectum very rapidly and permanently arrested the hemorrhage. In other cases, equally good results were obtained. Sir T. Oliver (*Pract.*, June 1912).

Case of a woman of 50 who suffered from a hemorrhagic diathesis and excessive climacteric hemorrhages and extravasation of blood which was growing rapidly worse. The writer injected 40 c.c. (10 drams) of defibrinated blood from the patient's daughter. The hemorrhage stopped on the same day. Rubin (*Münch. med. Woch.*, Oct. 1, 1912).

Case in a boy aged 5 who, when seen six days after the injury, presented an almost hopeless case. The only thing left to be tried was human serum, and after carefully preparing the father's arm the median basilic vein was opened and about 8 ounces (240 c.c.) of blood received in a sterile bottle, which was placed in an ice-box for ten hours. Then 20 c.c. (4 drams) of the serum was injected subcutaneously into the child's buttock, and within twenty minutes a clot formed

on the child's tongue and the bleeding almost ceased. The clot became so large that it had to be removed in twelve hours, but there was no renewal of the bleeding. Traver (*Jour. Amer. Med. Assoc.*, Jan. 4, 1913).

In a case of war wound in a hemophilic described by the writers, the young man, his brother, his mother and her brother were all bleeders. The bleeding always stopped spontaneously about the twelfth day, regardless of the measures applied. Wounded in the hand, the hemorrhage kept up for the usual 12 days and then stopped, but the anemia was fulminating and extreme. Analyses showed there was no lack of fibrinogen or calcium salts. Neither horse serum nor beef serum accelerated coagulation, which demonstrates that these serums do not supply a lacking thrombozym but act as antigens, inducing an organic reaction. Fresh human serum shortened the interval before coagulation but this effect was still more marked with white corpuscles from normal human blood. When washed white corpuscles were added to the hemophilic blood, coagulation occurred rapidly. This seemed to show that the white corpuscles supplied the element which was lacking in the hemophilic blood. It is possible to obtain a leukocyte clot which might aid in arresting a hemophilic hemorrhage applied directly to the bleeding spot. Their method is to draw 5 or 10 c.c. ( $1\frac{1}{4}$  to  $2\frac{1}{2}$  drams) of venous blood into twice its volume of  $\frac{1}{2}$  alcohol (*alcool au tiers*), then agitate. Centrifuge immediately and decant the hemolyzed fluid. The clot of leukocytes left can then be applied directly to the bleeding surface. Fieissinger and Montaz (*Lyon chir.*, July-Aug., 1917).

Gelatin was formerly recommended but it has failed in many instances, and is by no means as efficient as blood-serum. A sterilized preparation should alone be used. It may be used locally by the mouth or rectum.

It was found that **gelatin** causes an increase in the viscosity, especially when given under the skin. Thus, in a case of hemoptysis the internal administration of 200 c.c. (6½ ounces) causes the viscosity to rise in ten days by 0.6 in relation to the original value, while the injection of 40 c.c. (10 drams) of **sterile gelatin** solution caused it to rise in twenty-four hours by 1.4. Gelatin given hypodermically is less exposed to fermentative process than when it is given by the mouth. Increase in the specific gravity of the blood is one of the factors in its hemostatic effect. Cmunt (Med. Klinik, Aug. 25, 1912).

**Adrenalin** sometimes proves very useful. It should be applied in the form of the 1:1000 solution, or the **adrenalin chloride** salt may be applied to the bleeding surface directly.

In 1 case the author arrested the bleeding from the nose with 1 local and 1 subcutaneous application of **pituitary extract**. H. Neumann (Med. Klin., Jan. 28, 1923).

**Thromboplastin** is obtainable in filtered, sterile solution, put up in ampules each containing 20 c.c. (5 fluidrams). The entire contents of 1 ampule should be injected intravenously at a dose. For local control of the hemorrhage in dental cases 5 minims (0.3 c.c.) of **adrenalin** solution can be added extemporaneously to 32 minims (2 c.c.) of physiologic saline solution and injected into the bleeding tissues. A larger amount would be liable to induce sloughing, and would also markedly raise the blood-pressure. R. Friedman (Dent. Cosmos, Sept. 1925).

**Peptones**, preferably when rich in propeptone or albumose, such as that used in laboratories for culture media or **Witte's peptone** in 5 per cent. solution, have been praised by European writers and by some found superior to blood-serum. A clear solution is necessary, however; other-

wise untoward general phenomena may be produced. Nolf recommends that **propeptone**, such as the above, be placed in fresh salt solution and boiled. When filtered and sterilized to 120° C. a perfectly clear and harmless solution is obtained, which will prove very efficient as an hemostatic.

In 9 cases hemophilic hemorrhage was arrested by injection of 10 c.c. (2½ drams) of a 5 per cent. solution of **peptone (Witte)**. In some of the cases 2 injections were given as a prophylactic measure, in the first 10 and the second 2 days before a major operation. The patients were between 6 and 67 years old, and a single injection answered the purpose in nearly every case. The peptone is more easily sterilized than serum; heating to 120° C. (248° F.) for an hour does not alter its properties. It is injected as a 5 per cent. solution in a 0.5 per cent. solution of **sodium chloride**. There seems to be no danger of anaphylaxis. P. Nolf and A. Herry (Revue de méd., Feb., 1910).

**The mother's blood** is just as efficient for transfusion in melena cases as that of any other donor. The mother should, indeed, be used as donor in every case. Cherry and Langrock having shown her blood can be used safely without hemolytic tests in newborn infants, whereas the father and other blood relatives require a careful test to prevent hemolysis and agglutination. This fact is of the greatest importance because it is almost impossible to obtain enough blood from the infant for the necessary tests. Valuable time is saved. R. Lewisohn (Amer. Jour. of Obstet., June, 1918).

In a case of hemophilia with hematoma in the floor of the mouth, impeding respiration, the authors used a transfusion of 20 c.c. of **citrate maternal blood** together with several injections of 5 c.c. (80 minims) of 10 per cent. **peptone** solution. The hematoma was also punctured and ice applied to the neck. It began to diminish on the

fourth day and subsided entirely after about a month. Fiessinger and Barbillou (Bull. Soc. méd. des hôp. de Paris, Mar. 2, 1922).

In 2 cases of hemophilia, the writers used **sodium citrate**, injecting intravenously 4 Gm. in 100 c.c. of physiologic **sodium chloride solution**. There was immediate prolongation of clotting time followed by a marked shortening. These effects appeared to be related to changes in the blood platelets. L. D. Cady and E. L. Shrader (Jour. of Lab. and Clin. Med., June, 1924).

**Actual cautery** has been used with success to arrest hemophilic hemorrhage of the gums—usually a very stubborn form, owing to the proximity of the carotids.

**Roentgenotherapy** is of value in hemophilia, purpura and similar hemorrhagic affections. Clotting is produced by fibrin ferment elaborated by endothelial cells, which may be actively stimulated by the X-rays, when used in small or moderate doses which do not diminish the erythrocytes. Satisfactory results are obtained either by treating the spleen or by exposing large areas of the skin at a long focal distance. J. and V. Garcia Donato (Siglo méd., June 30, 1923).

In the treatment of joint disorders due to hemophilia they should be firmly **bandaged** when swollen and **kept at rest** until the effusion subsides. Unless this be done the ligaments become stretched and weakened, and the onset of osteoarthritis is hastened.

The treatment of the anemia following copious hemorrhages is the same as that of the ordinary form of the disease, **iron** being of special value. But with it should be given **pituitary, adrenal, or thyroid gland**, all of which tend to enhance the formation of coagulating ferment. Inhalations of **oxygen** at this time

greatly hasten recovery. **Calcium** though theoretically indicated is useless, except perhaps, if given intravenously.

Intravenous injections are preferable to other routes of administering **calcium chloride**. In 3 cases of grave hemophilia they found the injections reduced the coagulation time by 35, 23 and 16 minutes, respectively, the tendency to hemorrhage subsiding simultaneously. Oral administration seemed futile. About 20 c.c. of a 5 per cent. solution was usually employed for each injection, the treatment consisting of 1 or 2 series of 10 or 12 injections. Carnot and Blamoutier (Paris méd., Dec. 6, 1924).

In a case of hemophilia in a syphilitic man, 63 years of age, there was present a subhyoid hematoma as a complication. The hemophilic manifestations in the blood were seemingly the result of the syphilis, since under **neosarsphenamin** injections recovery took place. Paisseau, Cayla and Hamburger (Bull. Soc. méd. des hôp. de Paris, June 19, 1925).

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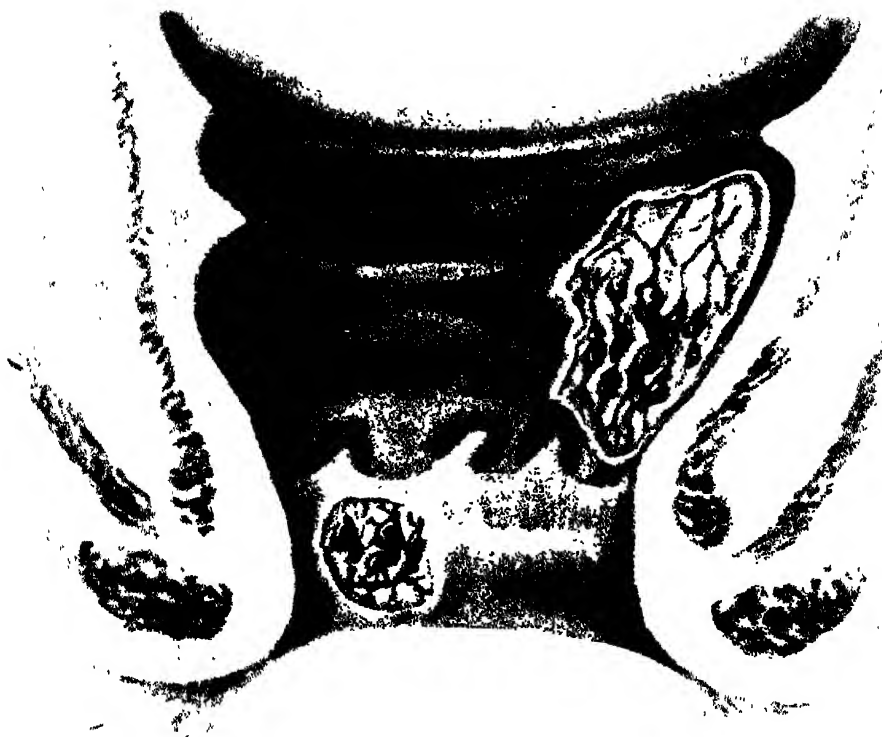
**HEMOPTYSIS.** See LUNGS, DISEASES OF.

**HEMORRHAGE.** See various conditions in which it occurs.

**HEMORRHAGIC DISORDERS OF THE NEWBORN.** See NEWBORN, DISORDERS OF, and ADRENAL HEMORRHAGE.

**HEMORRHOIDS.**—A hemorrhoid or pile is a vascular tumor of the rectum or anus, composed of varicose or thrombosed veins of the superior or the inferior hemorrhoidal systems. The middle hemorrhoidal veins, draining, as they do, the outer surface of the rectum and the upper surface of the levator ani muscles, do not enter into the formation of piles.

Clinically and morphologically,



Rectal mucosa and anal skin removed, showing the superior and inferior hemorrhoidal veins. Some hypertrophied anal papillae are shown at the anorectal line. (*Collier & Martin.*)





Section showing the superior and inferior hemorrhoidal veins and their anastomosis at the anorectal line. (*Collier F. Martin.*)





hemorrhoids may be differentiated as two main varieties, namely, external and internal. From an embryologic point of view, these two varieties must be considered as distinct, the anorectal line or dentate border being the true dividing line between them. *External hemorrhoids* are the result of pathological processes involving the inferior hemorrhoidal plexus of veins. *Internal hemorrhoids* result when the superior hemorrhoidal system is involved.

**EMBRYOLOGY.**—This is an important feature of the whole subject. The anal canal is developed from the outer layer of the blastoderm, or ectoderm. The infolding of the ectoderm at the site of the anus is called the proctodeum, or rudimentary anus. The rectum, on the other hand, is developed from the inner layer of the blastoderm, or entoderm. From the entoderm is developed the hind-gut, part of which goes to make up the rudimentary rectum. The rectum, at first, is separated from the proctodeum by two layers of mesodermic tissue, between the layers of which is developed the pleuroperitoneal cavity. As the rectum and the anal canal become more fully developed, these mesodermic layers are pressed together and become absorbed at the point of fusion. Where this absorption is normal, the anal canal becomes patulous, the line of union between the rectum and anus constituting the anorectal line or dentate border. As might be expected, the blood-supply of the rectum and anus are anatomically distinct, being separated by this line. Above this line the rectum is drained by the superior hemorrhoidal veins, which reach the portal circulation

by way of the inferior mesenteric vein. Below the dentate border, the anus is drained by the inferior hemorrhoidal veins, which run downward and outward, to the internal pudic veins. These veins, in turn, carry the blood to the inferior vena cava. While the blood-supplies of the anus and rectum are distinct, it must be remembered that there is a slight anastomosis between the superior and the inferior hemorrhoidal vascular systems. The middle hemorrhoidal vessels also anastomose both with the superior and the inferior hemorrhoidal arteries and veins. In cases of long-standing hemorrhoidal disease involving the two systems (the superior and inferior), the anastomosis becomes quite extensive, at times being so pronounced as to be easily demonstrable to the naked eye.

The anal canal, being developed from the ectoderm, is lined in its entirety by skin. This skin, because of its protected position, possesses certain peculiarities of cellular structure. This skin is called mucocutaneous. The term "modified skin" would be more appropriate and less confusing. The differentiation between external and internal piles becomes a simple matter when we take into account the anatomy of the parts. An external hemorrhoid may be recognized by the fact that it is *always* covered by skin, that all of the tissue involved lies below the anorectal line, and by the fact that the veins all belong to the inferior group of vessels. An internal pile is *always* covered by mucous membrane and limited at its lower border by this same anorectal line. The veins here involved belong to the

superior hemorrhoidal system and are connected with the portal circulation by the inferior mesenteric vein. It makes no difference how far a pile is prolapsed, it is always an internal hemorrhoid if covered by mucosa. Sometimes a large hemorrhoidal mass is seen which is covered by both mucosa and skin. This type of tumor has been called a combination or compound pile. A compound pile is composed of two distinct parts, an internal and an external pile, which lie in the same axis of the circumference of the bowel. When a compound hemorrhoid becomes strangulated and swollen, the two portions of the tumor will be seen to be separated by a deep, well-defined groove. This groove is formed by the anorectal line, and is rendered more apparent because it separates the superior from the inferior vessels, and the submucosa from the subcutaneous tissue of the anus. The submucosa of the lower rectum, being but loosely applied to the muscular wall of the rectum, allows the mucosa and the varicose veins to roll over the anorectal line and thus to become prolapsed.

Not only does the anorectal line form a barrier-reef between the distinctly different blood-supplies of the anus and rectum, but at this same line the nerve-supplies become differentiated. Below the anorectal line, the skin of the anus, the subcutaneous tissue, the external sphincter, and the levator ani muscles have a direct spinal innervation, derived from the third to the fifth sacral, and the coccygeal nerves. The rectum, beginning at the dentate border, or at the free borders of the semilunar valves of Morgagni, is supplied only by visceral branches, derived from the

second and third or the third and fourth sacral nerves. According to Piersol, while these fibers seemingly are derived directly from the spinal cord, they may be described more accurately as white rami communicantes, and reach their points of distribution only by way of the pelvic sympathetic plexuses. These nerve-fibers do not carry any of the specialized spinal sensations, such as touch, pain, heat, or cold. These visceral nerves, supplying, as they do, the involuntary musculature of the rectum, as well as the submucosa and the mucosa, do, however, carry pressure sensations. Their principal, and possibly only functions are motor and secretory. Necessarily, there must be afferent fibers, but the sensations are concerned only in carrying out the functions peculiar to the rectum itself, and are not of the protective type, such as we see resulting from irritation of the spinal nerves having a peripheral distribution. Because of this difference in the tegument, in the venous distribution, and in the innervation of the rectum and anus, external and internal hemorrhoids differ greatly in their etiology and in their subjective phenomena and objective characteristics.

Hemorrhoids may cause trouble in various ways: (1) By direct irritation—itching, bleeding or pain from fissures; (2) by reflex disturbances through the gastrointestinal tract—constipation, flatulence, nausea or vomiting; (3) by absorption of bacterial products from infected areas in the rectal crypts, which may cause systemic disorders similar to those from infected tonsils or other focal infections. The subjective symptoms of rectal lesions are lassitude, nausea, somnolence, vague fears, indefinite pains and numerous fatigue phenom-



Multiple thrombosis in an external hemorrhoid. Microscopic section, showing: Skin covering normal. Marked inflammatory reaction in the subcutaneous tissue with evidences of new tissue formation, accounting for the residual hypertrophy, and formation of skin tags after the thrombi have been absorbed. (Collier P. Martin)



ena—so-called neurasthenia; some of these may be attributed to absorption of septic products, others to mechanical irritation. The objective symptoms are reflex disturbances principally, but they may also be toxic from focal infection, or secondary to constipation or other abdominal conditions; not infrequently they resemble those of duodenal ulcer. Severe vomiting with abdominal pain, and flatulence, with or without distention, are characteristic symptoms of disturbed function of the small intestine which are frequently due to rectal irritation. G. R. Satterlee (Va. Med. Mthly., Sept., 1924).

Warning against the "snapshot diagnosis" of hemorrhoids. Careful routine proctosigmoidoscopic examination will avoid numerous mistakes. Following are instances of unexpected non-hemorrhoidal lesions that may be thus revealed: (1) Pain upon defecation: Anal fissure. (2) Protrusion from rectum on defecation: Prolapse of rectum. (3) Bleeding and soreness on defecation with intermittent soreness at other times: Chronic ulcer of rectum. (4) "Itching piles": Condylomata. (5) Persistent bleeding and some pain on defecation: Adenocarcinoma of rectum. J. F. Montague (Med. Jour. and Rec., June 17, 1925).

### EXTERNAL HEMORRHOIDS.

External hemorrhoids present three varieties for consideration, namely, the *thrombotic pile*, the *cutaneous hypertrophy*, and the *intra-anal varicosity*.

The **thrombotic hemorrhoid** is an acute condition, coming on suddenly, accompanied by a sense of fullness and discomfort. Inspection reveals a swelling of the skin at the margin of the anus, ovoid in form, the blue color of the clotted blood showing through the skin, particularly when the skin is rendered tense by slightly stretching it over the tumor. At times the skin is acutely inflamed, being congested and discolored. Where the

thrombus occurs in an old hypertrophied, cutaneous tag, or where the thrombosis is multiple, the skin may be greatly swollen and edematous. While the occurrence of the single clot or thrombus is the rule, multiple thromboses are far from rare. When the thrombosis occurs within the anal canal the clot is more apt to be cylindrical in shape, so that the course of the vein involved can be clearly defined upon palpation. In this form there is apt to be much sphincter-spasm, and consequently more pain. These collections of blood often are found to be covered with a thin capsule, which consists of one or two of the coats of the ruptured vein. Where the vein-coat is completely ruptured, extravasation into the cellular subcutaneous tissue is apt to occur, simulating a circumscribed bruise or irregularly shaped hematoma.

Thrombotic piles are essentially traumatic in origin. This condition is apt to occur at stool, the result of muscular effort, whether the bowels are loose or constipated. It occurs more frequently in the male sex, probably due to the relatively greater development of the anal sphincters and the accessory muscles of defecation. Great muscular effort, from lifting heavy weights, or, in fact, any form of exertion which may be associated with a sudden elevation of the intravenous blood-pressure, is an important causative factor. There seems to be a large class of individuals that, by reason of some inherent weakness of the vein-coats, is particularly prone to attacks of thrombosis. Patients in this class suffer from repeated attacks. Thrombosis of the inferior hemorrhoidal veins frequently is associated with an attack of acute

strangulation of internal piles, their presence adding much to the misery of the patient and somewhat complicating the case from an operative standpoint. The condition is a frequent complication following the traumatism of childbirth.

Perianal and anal thromboses pursue one of three courses: the acute inflammatory symptoms rapidly subside, accompanied by a gradual reduction in the size of the clot due to absorption, or else the clot may become infected, through the presence of pyogenic bacteria, and an abscess result, or, more rarely, the skin may become necrotic from pressure, and the clot be spontaneously extruded, accompanied by profuse hemorrhage. The rupture of one of these abscesses results in the formation of a small fistula. On the other hand, since the perianal lymphatics drain into the lymphatics of the inguinal region, the infection may spread in this direction, resulting in a bubo.

Even when absorption of the clot takes place, a slight thickening of the skin at the site of the pile is usually left, leading us to suspect that at least a low grade of local infection is the rule. When once a vein has been ruptured it never regains its tone, and clots are apt to recur, so that it is no unusual thing to obtain a history of repeated attacks occurring in the same place. After each succeeding attack the skin and the subcutaneous tissue become more and more hypertrophied from the deposit of inflammatory exudate, giving rise to the cutaneous tags or hypertrophic form of external piles.

The diagnosis may be made from the history of a lump appearing suddenly under the skin at the margin

of the anus or within the anal canal, accompanied by more or less spasm of the sphincters and consequent pain. Parenthetically, it may be stated that the amount of pain experienced in anorectal disease, not due to suppuration, is directly proportionate to the amount of sphincter-spasm induced by the lesion. The patient feels as if a foreign body were present in the anal region. Constipation, if not already present and an etiologic factor in producing the condition, may result from irritation of the sphincters and from the fear of the pain occasioned by the act of defecation.

The **cutaneous tag**, or the **hypertrophic form of external hemorrhoids**, consists of a prolongation and overgrowth of the anal skin, produced by repeated attacks of inflammation. As mentioned before, they frequently follow the absorption of anal thrombi, but just as often they are caused by infection. Infection of the proctodeum, by blocking up the anal lymphatics, tends to leave an inflammatory deposit in and under the skin. Persons suffering from constipation associated with excessive straining at stool frequently develop these folds through a prolapsus of the anal skin, while almost constant congestion is productive of inflammatory changes. In stricture of the rectum, whether benign or malignant, a pronounced ring of hypertrophic skin-folds is usually present. This is associated with a patulous condition of the anal orifice, which, when present, is almost diagnostic of rectal obstruction. A patulous anus associated with a marked overgrowth of the anal skin is often seen in cases of spinal involvement where the sphincteric reflex is diminished, as observed in

cases suffering with locomotor ataxia. A careful examination of the nerve reflexes will clear up the diagnosis. Even in these cases, the thickening and overgrowth is probably due to inflammation and infection. In this type of cases we have the two factors of displacement or stretching of tissue and of inflammation at work.

This strangulation differs somewhat from that of prolapsed internal hemorrhoids, since the tumors are not caught in the grasp of the sphincters. The swelling of the skin is not caused by vascular congestion entirely, but is partially due to a lymphatic stasis resulting in extensive edema. Where there is extensive edema there is apt



Multiple anal thrombosis with slight edema. The little tumor protruding at the posterior margin of the anus is a hypertrophied anal papilla which has become polypoid in form. (Martin.)

Under ordinary conditions these skin tags give little trouble, other than the annoyance of their presence and in the added difficulty of keeping the parts clean. Patients often are blamed unjustly for being dirty in their habits, when, as a matter of fact, even with the greatest care they find it impossible to keep the perianal tissues clean, due to the extreme unevenness of the surface.

These folds are subject to attacks of acute inflammation, associated with a condition of partial strangulation.

to be associated a multiple thrombosis of the inferior hemorrhoidal veins; indeed, it is probable that, in these cases, the thrombosis antedates the production of the edema, and may be the causative factor thereof. Should an anal eczema or a pruritus be present, the condition will be greatly aggravated. Suppuration may occur, resulting in the formation of a marginal abscess, to be followed by a fistula.

We need be concerned with the symptoms of the above forms of piles



only when they are affected with some complication such as acute inflammation, strangulation, thrombosis, an associated anal eczema, or suppuration. At these times the patient is in exquisite misery, due to the inflammation of the parts and to the excessive spasm of the sphincters. Because of the rich spinal nerve supply of the anal tissues, the pain usually is much greater than is experienced in an attack of strangulated internal hemorrhoids unassociated with excessive anal inflammation. Constipation is the rule, and patients often render themselves more miserable by futile attempts at placing the swollen masses within the rectum, under the mistaken notion that they are prolapsed internal piles. The fact that the tumors are covered by skin, and not by mucous membrane, will instantly clear up the diagnosis.

The third variety of external hemorrhoids, the **intra-anal varicosity**, is not often mentioned as a distinct variety, being confounded with the internal variety. Normally, the inferior hemorrhoidal veins, just within the anus and before they pass over its lower margin, are of slightly larger caliber than they are after leaving the anus to join the internal pudic veins. In some cases the anal aperture appears normal, but when the patient is requested to strain down, these veins may swell up tremendously, producing quite a large tumor. It is not uncommon to find such a mass of varicosities situated just below a hypertrophied anal papilla. We have seen one of these hypertrophied papillæ, with an intra-anal pile below it, removed under the impression that it was an internal hemorrhoid. The fact that the tumor was covered by

modified skin should have shown the operator to which class it belonged. Under the influence of muscular effort, the tumors become globular or fusiform in shape, and the dark veins may be seen distinctly, shining through the skin, giving much the same appearance as would be seen in a case of intra-anal thrombosis, but without the production of a distinctly hard tumor. The distinction is an easy matter, for the tumor is compressible and painless, and when the patient ceases to strain, the tumor gradually disappears. Should a thrombus be present, it will be painful, firm to the touch, and does not tend to disappear when the muscular straining is stopped. In a compound pile it is this portion of the inferior hemorrhoidal veins which fuses into the internal pile above, although it must be remembered that these intra-anal piles may exist even where the other varieties are absent.

The etiology of this form is somewhat doubtful. From the frequency with which the condition is met in young people, where no other lesions are present, it is possible that the condition results from a congenital weakness of the veins, or that it is a form of diffuse angioma. In long-standing cases of internal and external hemorrhoids, these veins would naturally become varicose, due to the constant engorgement, stretching, and chronic inflammation present.

When not inflamed, this form of pile produces no symptoms other than the production, at the time of stool, of a tumor mass, which is mistaken for a prolapsed internal pile. Where a greatly hypertrophied anal papilla limits the upper border of an intra-anal pile, this may be caught by

the sphincters, producing a great deal of swelling and exquisite pain.

According to Sir Charles Ball, when internal hemorrhoids are prolapsed, there occurs a revolution of the lower zone of the anal canal, forming a well-defined ring about the protruded mass, frequently mistaken for external piles. Separating this ring from the hemorrhoids is an irregularly, but sharply, defined sulcus, formed by the anorectal line. It is this revolved anal border which produces the annoying swelling following operations on internal piles, often leading one to feel that too little tissue has been removed. This edema slowly subsides after operation, at times leaving little skin tags. These, if annoying to the patient, may be scissored off under local anesthesia.

**TREATMENT OF EXTERNAL HEMORRHOIDS.**—Logically, the treatment of external hemorrhoids consists in the removal of the offending tumor or tumors. We also endeavor to mitigate and allay the subjective symptoms, and, if possible, prevent a recurrence of the condition, by removing the cause, where known.

Each case should be examined as to habits of life and eating, as this will suggest prophylactic measures. Elevation of the buttocks acts favorably. At first a **diet** of milk and vegetables is indicated. Substances likely to cause mechanical irritation, such as raspberries, gooseberries, kernels and skins should be avoided. If the diet fails to yield soft stools, **compound licorice powder**, 1 or 2 teaspoonfuls in the evening, or a mixture in equal parts of powdered **senna**, **calcined magnesia**, **washed sulphur** and **potassium bitartrate**, 1 level teaspoonful 3 times daily, is indicated. **Cascara sagrada** is also permissible. **Small oil enemas**—75 to 100 c.c. (2½ to 3½ ounces)—adminis-

tered through narrow, soft rectal tubes, act favorably, but all enemas which would irritate the mucosa are to be banned. Toilet paper should not be used. After each defecation the anal region should be cleansed with cotton and olive oil or by washing with 3 per cent. **boric acid** solution or a solution of 1 teaspoonful of **tannic acid** in a quart of water. L. Kuttner (Deut. med. Woch., July 18, 1924).

The most effective and most satisfactory method, both to the patient and to the attending physician, is immediate operation. Such dread is there of surgical interference that often we are forced to accede to the wishes of the patient for palliative treatment. Again, on account of the presence of some other pathological condition, we may be compelled to forego operative interference.

The pain, in all cases of external piles, is the result of two factors: the local inflammation or infection of the parts, and the sphincteric spasm.

From clinical experience, we will have to admit that **diet**, *per se*, seems to play a very unimportant part either in the causation of external piles or in the relief of their unpleasant symptoms. Of course, foods which cause intestinal irritation, thereby producing frequent stools and increased muscular spasm, must be avoided. Food producing constipation, because of the excessive straining at stool, may be a factor in producing an attack of anal thrombosis or strangulation, and this would materially add to the discomfort of a patient during an attack of this distressing malady.

Traumatism, muscular exertion, exposure and physical exhaustion, and acute infection seem to play a far more important rôle than does diet.

It is not so much the quality of the food taken as it is the quantity. Overeating, resulting in general functional disturbances, such as increase in blood-pressure, constipation, diarrhea, and faulty metabolism, and in faulty secretion and excretion, should be discouraged. **Moderation in eating and drinking** should be the rule.

All varieties of *acute external piles* are greatly relieved by soothing and mild antiseptic washes and lotions, or by mild ointments. Our best efforts are directed toward the reduction of the local inflammatory condition and the relief of the spasm of the sphincters, where this exists. At night a **wet dressing** of a **saturated solution of boric acid**, or of the old, reliable **lead water and laudanum**, gives marked relief both from the local spasm and the inflammation of the swollen mass.

Where but little inflammation or hemorrhage occurs the following ointment is advisable:—

℞ *Cerati*,  
*Olei amygdalæ expressi*,  
*Zinci oxidi*,  
 āā ..... ʒiiss (10 Gm.).  
*Balsami Peruviani* ..... gtt. iij.

Piece of this of size of hazelnut to be introduced high up through anus morning and evening, and especially before stool.

Where much hemorrhage, following may be used:—

℞ *Chrysarobini* . gr. xij (0.8 Gm.).  
*Iodoformi* ... gr. v (0.3 Gm.).  
*Extracti belladonnae fol.* . gr x (0.6 Gm.).  
*Petrolati* ..... ʒj (30 Gm.).

Hot water or **antipyrin** in powder or 2 per cent. solution is equally effective and less irritating.

Where the itching is intense:—

℞ *Aluminis* ..... gr. xv (1 Gm.).  
*Camphoræ* ... gr. xij (0.75 Gm.).  
*Adipis benzoinati* ..... ʒj (30 Gm.).

Where much *moisture* and also *itching*, 10 per cent. **bismuth subsalicylate** powder useful. If much congestion is present:—

℞ *Bismuthi subsalicylatis*,  
*Zinci oxidi*, āā gr. lxxv (5 Gm.).  
*Talci* ..... ʒiij (90 Gm.).

In voluminous, readily prolapsing or bleeding hemorrhoids, an injection of **olive oil** should be taken every evening before retiring. Plicque (Bull. méd., June 1, 1912).

We have always felt that the use of belladonna to relax the sphincters was somewhat of a delusion and a snare, the drug having practically no effect upon the striated external sphincter. Where belladonna is used freely, either by suppository or as an ointment, very disagreeable consequences are apt to follow in persons susceptible to the influence of the stronger alkaloids.

During the day, there may be applied to the parts an **acetanilide ointment** composed of:—

℞ *Acetanilidi* ..... ʒss (2 Gm.).  
*Ung. aquæ rosæ* ..... ʒj (30 Gm.).

In addition to the antiseptic qualities of the acetanilide ointment, it has a decidedly sedative and anesthetic effect. The official **ointment of zinc oxide** or that of **calomel** is also very soothing.

The writer has had good results from the following ointment as a palliative in internal hemorrhoids:—

℞ *Solution of adrenalin* ..... m̄x (0.6 c.c.).  
*Lanolin* ..... ʒj (4 Gm.).

M. et ft. unguentum. Apply liberally to the anal canal once or twice daily.

For constipation in these cases the writer has advised **cascara** or **olive oil**, in combination with grape juice if desired. The temporary use of an injection of **cold water** after breakfast for a period not extending over two weeks is a good way to start the habit of moving the bowels at a regular time of the day. Bodkin (Amer. Med., May, 1911).

The writer found **injections** of 96 per cent. **alcohol** the most effective measure in 62 cases. His technique is as follows: The bowel is cleansed by catharsis and soap-suds enemas. Then, with the patient in the knee-elbow position and under local anesthesia, suction is applied to the venous knot. Next, the 96 per cent. solution of alcohol is injected deeply into the extra-anal knots, 2 ccm. into the small knots and 5 ccm. into those which were larger. After the injection the hemorrhoids are left outside or pushed high up into the rectum. Following this treatment the hemorrhoids become necrotic and slough off within a period varying from 6 to 14 days. The method is indicated in all cases of prolapsed hemorrhoids even though they may recede spontaneously. In cases of hemorrhage, rectal injections of 5 per cent. **calcium chloride** are given. In 64 per cent. of the cases healing occurred normally, but in 36 per cent. it was interrupted by recurrent hemorrhage, pain, and retention of urine. There was a recurrence in but 2 instances. Boas (Deut. med. Woch., Oct. 10, 1919).

If a **suppository** seems to be indicated, one composed of 3 minims (0.2 c.c.) of **ichthyol** and 20 grains (1.3 Gm.) of cocoa butter will be found efficient. It must be remembered that the use of a suppository is simply a convenient method of introducing an ointment into the rectum, and if we use too much medicament in proportion to the amount of adjuvant the ointment may be too strong, causing local irritation.

We often forget that, when we crowd a number of active drugs into a suppository, we not only obtain the therapeutic effects of the drugs, but we also get such an amount of local irritation as to neutralize our efforts toward relief of the symptoms. **Lycopodium** or **licorice powder**, particularly the former, when used by the druggist as a dusting powder for the suppositories, frequently is causative of the most acute suffering by inciting spasm of the sphincters. This is particularly true when there is associated an inflammatory condition of the crypts of Morgagni.

**Suppositories of iodoform** have been used with marked benefit, but, in addition to its penetrating odor, it, in common with many of the iodine preparations, is apt to produce, in susceptible individuals, a very annoying dermatitis. Following a suggestion of the late J. P. Tuttle, we have found great relief from the spasm of the sphincters to result from the injection of about a dram (4 c.c.) of a 10 per cent. **solution of colloidal silver** into the rectum twice daily. A suppository also helps to lubricate the rectum at stool, lessening the irritation.

Should the sphincter-spasm, pain, and edema of the anal tissues be extreme, immediate relief may be obtained by **divulsing the sphincters**, preferably under the influence of nitrous oxide gas. This procedure may be placed midway between the palliative and the operative treatment, as the relief afforded from the symptoms is marked, even should the offending hemorrhoids be left *in situ*. Frequently the patient will submit to this mild operation when he would absolutely reject even the slightest cutting procedure.

There is not the slightest reason why the piles should not be removed while the patient is under the anesthetic, other than the fact that frequently consent to this radical procedure cannot be obtained. Of course, where large amounts of tissue must be removed the patient would better be in his own home, or, preferably, confined for a short time in a hospital, where the operation can be carried out under proper surgical precautions. We are convinced that any rectal operation which may be followed by either hemorrhage or infection, or where a good illumination of the parts must be obtained in order to properly complete the same, should, if possible, be performed in a hospital, where the proper surgical technique can be followed.

The usual directions that *external thrombotic hemorrhoids* should be transfixed by a sharp bistoury, the clot turned out, and the cavity packed are certainly very unsatisfactory in the performance of this little operation. The following day the cavity will be found to be filled with another clot, which has to be evacuated, while, at the same time, the overlying skin will be found to be swollen and painful to the touch. A far better method is **removal** of external thrombotic hemorrhoids, by grasping the entire mass of swollen skin and the underlying clot with a hemostat or a volsellum forceps and then, with a pair of scissors curved on the flat, removing completely both the clot and the overhanging skin, taking care that the incision is carried far enough so that the thrombosed vein is cut off where it is perfectly healthy.

As a rule, the hemorrhage following the incision is slight. Bleeding

vessels may be caught and twisted, or, if deemed necessary, ligated. The wound, being perfectly flat, may be dressed with a simple pad of sterile gauze, held in place with a "T-bandage." Because of the retraction of the tissues, even an apparently extensive denudation is almost immediately converted into a linear wound, which will heal in a few days, requiring no attention other than surgical cleanliness.

Where the thrombus is large, the skin is so stretched by the clot and by the associated edema that, while we apparently have removed a large area of anal skin, in reality only a small portion has been excised.

*Cutaneous tags or hypertrophic external hemorrhoids* should be treated by **removal**. They may be scissored off level with the surrounding anal skin, care being taken to leave islands of skin between the denuded areas, so that there may be little or no contraction of the anal orifice. Occasionally, sutures are inserted to hold the skin edges in apposition, but this seems unnecessary if the denuded areas are made in such a manner as to form lines radiating from the center of the anal canal. The retraction of the anal tissues will convert seemingly broad wounds into linear ones, which will heal promptly.

*Intra-anal varicosities* requiring surgical interference should be carefully **dissected out**, and the **vessels ligated or twisted** to prevent hemorrhage. Should a *hypertrophied anal papilla* be present, this should be **removed** at the same time. A simple gauze pad should be placed over the anus. No packing should be inserted into the anal canal, as the packing keeps the parts on a tension, spread-

ing the wounds, and thus lengthening the process of repair.

While all forms of hemorrhoids can be operated upon under local anesthesia, general anesthesia is preferable. Local anesthesia will always have its field of usefulness in anorectal surgery, but it has certain limitations. Children and nervous patients are difficult to control. In addition, the extreme swelling of the tissues necessary to obtain anesthesia with the weak solutions now used, causes a very annoying distortion of the surgical landmarks, making accurate surgery difficult, if not impossible. The best cosmetic results are to be obtained only when the patient is perfectly under our control, and where the pathology of the part is not obscured by artificially induced edema.

### INTERNAL HEMORRHOIDS.

Internal hemorrhoids, in all probability, begin as simple varices, although repeated attacks of inflammation may result in the production of local cavernous angiomata, thus forming true tumors. A so-called strawberry pile has been described, but this condition will be found to result from a dilatation of the capillaries of the rectal mucosa resembling a nevus in structure, but does not form a palpable tumor. Thrombosis of the superior hemorrhoidal vessels occurs, usually, as a complication of the ordinary varicosity, as the result of strangulation, and will be considered only as a complication and not as a distinct variety.

The etiology of internal hemorrhoids has been rendered so complicated by the multiplication of causative factors that some attempt to simplify the matter, by classifying

these factors into general groups, seems imperative.

The mechanism of the formation of internal hemorrhoids or rectal varices consists, first, in the establishment of a venous engorgement or stasis; secondly, in the elongation, stretching and dilatation of the venous loops, followed by the production of a tortuosity of these veins; and lastly, in a secondary inflammation or a low grade of infection, producing thickening of the vessel-wall, and inflammatory increase of the tissues of the submucosa and mucosa, producing a palpable tumor.

Venous engorgement or stasis of the superior hemorrhoidal veins begins in the most dependent portion of these vessels; in other words, in the little venous pools or blood-lakes situated in the submucosa just above the anorectal line. This stasis is purely mechanical, and is occasioned by any factor which offers resistance to the passage of the blood into the portal circulation. A direct tendency to engorgement is produced by the mere weight of the column of blood in these veins, which have no valves to distribute the back-pressure, and by the fact that the veins of the rectum have practically no support, lying loosely in the submucosa, not having muscular support, as do the veins in many other portions of the body.

It will be remembered that the superior hemorrhoidal veins leave the mucosa at a point about four and a half inches above the anal outlet, perforating the two muscular coats at this point, to be applied, more or less closely, to the outer surface of the longitudinal muscular coat of the rectum. At this point the veins pass through little buttonhole-like slits in

the muscular wall, and the theory, advanced by Verneuil, that these veins are here compressed, due to the contraction of the muscular coats, seems to possess some weight. The intravenous pressure may also be raised by pressure from without the rectum, as in the case of tumors, or a pregnant or misplaced uterus, or due to the presence of inflammatory or malignant tumors such as are seen in cases of stricture. Engorgement may also be caused by pressure from within the rectum, as from foreign bodies, or from the constant presence of feces. Probably there is nothing that raises the pressure of the blood in the lower portion of the veins of the rectum more than muscular action, such as is brought into play during the act of difficult defecation, or in lifting heavy weights.

Continued venous engorgement eventually results in stretching of the vein-coats, producing an elongation and tortuosity of these vessels. Just how much of a factor the weight of the unsupported blood-column plays in producing this elongation, is not clear, but certain it is that man alone, the only animal to persistently maintain the upright position, seems to be afflicted with rectal varicosities.

When many cases of internal hemorrhoids are examined, we are struck with the fact that the piles do not alone consist of simple varicosities, but that there is much added tissue, producing, oftentimes, a well-defined tumor. This adventitious tissue results from an inflammatory deposit not only in the coats of the veins themselves, but in a thickening and hypertrophy of the submucosa and of the overlying mucosa. When the pile is examined while protruded, it has a

dark-purple color, due to the distention of the varicosities with blood. When the hemorrhoid is seen through a speculum, in its flaccid state, it is dark red in color, and the small capillaries of the mucosa can be seen to be somewhat dilated. It seems highly probable that internal hemorrhoids become permanent tumors or angiomata only after persistent and numerous attacks of inflammation. The venous engorgement, followed by bacterial invasion, produces a localized phlebitis and periphlebitis.

The cardinal symptoms of internal hemorrhoids are bleeding, protrusion of the tumor mass at stool, a sense of fullness in the rectum, or the presence of a mucous discharge. Localized pain is present only when there is associated a cryptitis, a fissure, or when the piles are strangulated. Backache, pain over the sacrum or pubes, may be caused by other diseases of the rectum or of the urogenital tract which produce irritation of the pelvic sympathetic, and are not due to piles *per se*. The bleeding of internal hemorrhoids is usually venous in type, but may be of arterial origin. It usually occurs during or immediately after stool, as at such times the blood-vessels are extremely engorged. Attacks of bleeding are frequently ushered in with a history of some intestinal disturbance or infection, such as constipation, diarrhea, or even a bad cold. In other words, in many cases, the attacks of bleeding begin as the result of a mild proctitis, associated with more or less spasm of the sphincters. After a severe attack of bleeding the patient frequently seems far more comfortable, the local depletion of the tissues seeming to have a salutary effect on the condi-

tion. When the rectum is examined during one of these attacks, the mucosa will be found to be greatly congested, and at certain points on the surface of the piles will be noted small eroded areas. These erosions may be made to bleed by rubbing with a cotton swab. During the act of defecation, when the piles are protruded, the blood will be seen to ooze from the mucosa in quite a noticeable amount, trickling down and falling in large drops or even a steady stream into the toilet. At times, small rents or tears occur in the mucosa, and the blood is expelled in spurts. Theoretically, if the bleeding be of arterial origin, these spurts of blood should be synchronous with the pulse, while if it be of venous type, it should follow more nearly the rhythm of the respiration, and should be increased in quantity during the rhythmical contraction of the sphincter muscles. Accurate information upon this question is wanting. The localized muscular contractions of the sphincters, or spasms, seem to play quite an important part in producing rectal hemorrhage, for it has frequently been noted that the bleeding occurring at stool will cease, for from a few days to a period of months, following a divulsion of the sphincters. Excessive or repeated attacks of bleeding from the rectum may lead to a condition of profound anemia, which in a few instances has resulted fatally.

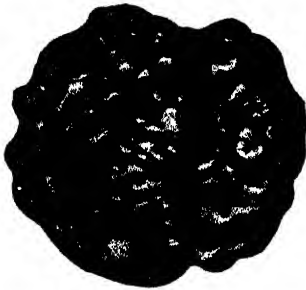
There seems to be a more or less prevalent belief that the protrusion of internal hemorrhoids takes place only when the sphincter muscles have become relaxed. This is supposed to occur when the pile has become large enough and the rectal mucosa sufficiently stretched to allow the mass to

be protruded through a flaccid sphincter. As a matter of fact, there is a very complicated and active mechanical process involved in the production of hemorrhoidal prolapse. The varicose veins constituting the vascular portion of the pile, in their course in the submucosa, are attached more closely to the mucous coat than to the muscular coat of the rectum. The tissue of the submucosa is arranged so loosely that, under perfectly normal conditions, the mucosa may be moved over the surface of the muscular coat for a distance of a half-inch or more. This condition is increased in pathological conditions. An internal hemorrhoid consists of a tumor composed of varicosities, thickened mucosa, and submucosa, which is more or less freely movable in the rectal ampulla. This tumor acts as a foreign body, both because of its pressure within the rectum and from the bacterial irritation, when active inflammation is present. The presence of a foreign body or of an acute inflammation in the rectum is accompanied by muscular effort on the part of the rectum to rid itself of the offending substance. Where the irritating stimulus is strong enough to produce subjective symptoms, we call the condition *tenesmus*. It is this muscular action, assisted by the friction of hard masses of feces passing through the rectum, that is concerned in the formation of polypoid growths from sessile tumors, and in the elongation of the mucosa covering an internal hemorrhoid. This tendency toward protrusion of piles is more pronounced when there is spasm of the sphincters than when these muscles are relaxed.

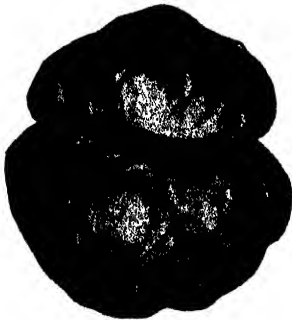
We frequently meet cases in which



the piles will protrude immediately they are replaced, and they can be made to remain above the sphincters only by allowing the patient to lie down for an hour or so after they have been replaced. After a **divulsion of the sphincters**, conditions are changed: the piles may protrude at



B



Thrombotic external and internal hemorrhoid (compound pile). (Martin.)

A, posterior surface of tumor, showing the veins filled with multiple thrombi. B, anterior surface. The deep transverse sulcus is formed by the anorectal line, separating the superior from the inferior hemorrhoidal vascular system. The modified skin of the anus ends abruptly at this line. Above, the tissue is covered by the normal rectal mucosa.

stool, but they tend to reduce themselves spontaneously after completion of the act, or else they can easily be replaced by the patient. The most noticeable fact is that they do not tend to prolapse as before, and the patient can immediately assume the erect posture without fearing that

the tumors will protrude. This condition of affairs is so marked that often the patient imagines that the piles have been removed and that he has been cured. This fact, and the fact mentioned above, that hemorrhage is temporarily arrested, has led to the erroneous belief that a divulsion of the sphincters will permanently cure hemorrhoids. While it is true that an acute attack, with its unpleasant and painful subjective symptoms, may be brought to an abrupt termination by this little operation, it must be remembered that the tumors, although reduced in size, remain, and, sooner or later, they will give rise to some subjective symptoms. Old chronic hemorrhoids, associated with a relaxed sphincter, usually are constantly protruded, and are associated with a more or less profuse discharge of rectal mucus. Where this condition is present, because of the relaxed condition of the sphincter muscles, patients rarely suffer from acute attacks of inflammation, with associated hemorrhoidal strangulation. The exposed mucous membrane keeps the perianal region and the underwear of the patient constantly moist and soiled.

Attacks of hemorrhoidal strangulation usually occur in patients having excessively irritable sphincters, particularly after the straining at stool caused by constipation, or by an overactive dose of a purgative used to relieve the constipation. Heavy lifting may also bring on an attack. Frequently these attacks follow exposure to cold or wet, or to an indiscretion in diet, or to excessive indulgence in alcohol. In these cases it is the associated constipation, or the efforts to relieve the constipation, that starts

the attack. The patient has a difficult or explosive stool, with sudden and excessive protrusion of the hemorrhoidal mass. The sphincters, under the influence of the sudden irritation, immediately contract about the protruded mass, thus preventing their spontaneous return into the rectum. The pressure of the sphincters, cutting off the return flow of blood from the superior hemorrhoidal veins, causes the mass to swell, effectually preventing the manual replacement of the piles. The veins in the strangulated tumor rapidly become thrombosed, the tissues greatly inflamed, and the patient suffers greatly.

**TREATMENT OF INTERNAL HEMORRHOIDS.**—The **palliative treatment** of internal hemorrhoids consists in the adoption, first, of such measures as will tend to prevent the further development of the tumors, and lessen the chances of future complications; secondly, of such measures as will relieve the subjective and objective symptoms already existing.

Constipation, particularly that type in which feces are retained for long periods of time in the rectal ampulla, is to be corrected where possible. Where this form of constipation is caused either by an overdeveloped or a spastic sphincter, marked relief may be obtained by a **divulsion of the sphincters**, either under nitrous oxide or local anesthesia. While **laxatives** may have to be administered, every effort should be made to create a regular habit on the part of the patient.

To reduce suffering in hemorrhoids, Barnes advises after defecation the use of only the finest tissue paper, followed by thorough, gentle cleansing with absorbent cotton, a wad of soft cotton cloth, or wet tissue paper, occasionally with soap. A dusting powder of **talcum** and **boric acid**,

10:1, is then applied with the finger-tip, covered with a dry cloth or tissue paper. Upon continuation of this procedure the delicate mucous membrane becomes more and more like skin. Lenhossek recommends a small, tepid **cleansing enema** after each defecation as a palliative.

The writer stresses induction of the **bowel movements before retiring**, discreet use of aperients to **prevent loose actions**, and application of **calamine powder** on a sanitary wool gauze pad held in place by tapes around the waist, to be changed in the morning and replaced by **hamamelis** or other **ointment** if the calamine causes discomfort during the day. Lyth (Brit. Med. Jour., Feb. 19, 1921).

**Moderation in eating and drinking** is advisable, not so much because of any direct influence they may have in producing hemorrhoids, but because these are apt to produce more or less irregularity in the evacuations, resulting in frequent engorgement of the rectal veins.

*Protrusion of the piles* at stool and upon exertion being, as mentioned above, so often due to muscular action, little can be done to relieve it. Astringent injections and suppositories are apt to increase the tenesmus. The **injection of half an ounce (15 c.c.) of olive oil, at bedtime**, may lessen the tendency to protrusion when the bowels are moved in the morning. A **suppository containing 3 minims (0.2 c.c.) of ichthyol and 20 grains (1.3 Gm.) of cacao butter**, inserted at night, answers the same purpose. The patient should be encouraged to try to have the bowels moved regularly, once a day at least, and also to try to avoid undue muscular straining. The rectum may be emptied of any fecal accumulation by a **small enema**. This should consist of about half a pint or a pint (250

or 500 c.c.) of tepid water, injected in the morning, at about the usual time for stool. If possible, the quantity should be decreased from day to day, rather than the reverse, and the temperature of the water may be reduced, until eventually the enema consists of an ounce or two (30 to 60 c.c.) of cold water, at the temperature that it comes from the tap.

The same methods may be used to control *the bleeding* when it occurs. Where this is severe, the mucous membrane may be swabbed off with a **solution of silver nitrate**, containing about 10 grains (0.65 Gm.) to the ounce (30 c.c.). The excess of silver should be neutralized with sodium chloride solution. A little **olive oil** or an **ichthyol suppository** may be left in the rectum to lessen *the tenesmus*. If the bleeding persists, a **divulsion of the sphincters** should be performed. This will stop the bleeding temporarily, but the patient should be warned that it will probably return, and should be encouraged to have the piles removed.

When *strangulation* occurs, patients are usually in a more susceptible frame of mind, and if they will submit to an **operation**, by all means advise it. While operations at this time present a few more difficulties to the operator, it is often the only time that we can induce a patient to submit to the intervention.

In strangulated hemorrhoids the writer keeps the patient in bed for 1 or 2 days, with nothing taken by mouth except a few spoonfuls of **sweetened water** every hour to a daily total of 200 or 300 c.c. (6½ to 10 ounces). **Hot compresses** are placed over the piles, which are later painted every second day with a weak **alcoholic iodine solution**. Leven (*Médecine*, July, 1921).

Should the patient refuse, as too often he will, he should be put to bed, and the **hemorrhoids replaced** if possible. This may best be accomplished by having the patient lie on the left side, with his buttocks slightly elevated, by placing a thick pillow under them, or he may be placed in the knee-chest posture. **Compresses, wrung out in very hot water**, should be applied to the parts, using **gentle pressure**. This pressure should be gradually increased. In a few minutes the swelling will be reduced and the sphincter muscles sufficiently relaxed so that, by gentle pressure, the prolapsed mass may be slipped through the sphincters.

If a finger be introduced into the rectum, gentle traction on the sphincters may relax them sufficiently to allow the piles to be replaced with ease. After the prolapse has been reduced, the anus should be greased with some **mild ointment**, and a firm **compress of gauze** should be applied, and held in place by a tightly adjusted "**T-bandage**." The patient should be **kept in bed** with the hips slightly elevated, until the acute inflammation has subsided. A **mild mixed diet** should be allowed, but milk, because of its constipating effect, should be avoided. The **bowels should be moved daily** either by enema or by a dose of **castor oil**. If the piles again protrude, they should be replaced immediately.

Where the prolapse cannot be replaced or retained, a **wet dressing of a saturated solution of boric acid** may be applied. A **hot-water bag** placed over the dressing, will serve to keep it warm and give the patient considerable comfort. The application of cold, in the form of an ice-bag, should

not be permitted, since severe sloughing of the parts is apt to result. Where the patient will submit to an anesthetic, but will permit of no radical operation, a **divulsion of the sphincters** will act like magic, relieving the pain and reducing the inflammation.

Stressing the importance of overcoming constipation, the writer recommends **cold enemas, cascara or rhubarb with malt, and mineral oil**; in children, **suppositories**. Inflamed and *prolapsed* piles are reduced with the patient in bed in an extreme oblique position; the hemorrhoidal mass is painted with 4 per cent. **cocaine hydrochloride** in 1:1000 **adrenalin** solution, and in 20 minutes will reduce spontaneously or be easily replaced. At times the external portion must be **incised**, to deplete it quickly. The whole anal region is then covered with **astringent ointment** and **gauze** strapped with adhesive.

In *inflamed hemorrhoids* a **warm, slightly antiseptic bath** and a **cold douche** should precede application of the ointment. The patient should lie on his face, later on his side, with hips elevated on pillows, never on his back. Next day, the **sphincter is dilated**, the hemorrhoidal fields **massaged**, the rectum and anal canal **irrigated with sterile water**, and the piles swabbed with 1:1000 **adrenalin**.

For marked *mucous discharge*,  $\frac{1}{2}$  ounce (15 c.c.) of fluidextract of **krameria** is injected at night. *Hemorrhage* can be controlled by the same measure and **rest** in recumbency.

Hemorrhoids *prolapsing at stool* demand **recumbency** and **cold compresses of adrenalin**; if replacement is needed, careful **washing with cold water**, coating with an ointment of **ichthyol, tannic acid and hydrastis**, and **replacement**. After stool, an **enema** of  $\frac{1}{2}$  pint (250 c.c.) of **cold water** constricts the tissues. **Bismuth subgallate** or **zinc oxide** check bleeding and relieve ulceration. (Ill. Med. Jour., Aug., 1921).

Where excoriations and pain are present, Noorden is quoted as recommending the following suppository: **Bismuth subgallate**, 0.3 Gm. (5 grains); **cocaine hydrochloride**, 0.02 Gm. ( $\frac{1}{2}$  grain); **adrenalin**, 0.1 c.c. ( $\frac{1}{2}$  minims); hydrated wool fat and petrolatum, of each, 2 Gm. (30 grains). Such a suppository is inserted in the morning after defecation and again in the evening before retiring. When moderate bleeding occurs, the following suppository is useful: **Calcium chloride**, 0.05 Gm. ( $\frac{1}{4}$  grain); **extract of hamamelis**, 0.03 Gm. ( $\frac{1}{2}$  grain); **balsam of Peru**, 0.1 Gm. ( $\frac{1}{2}$  grains); and cacao butter, 2 Gm. (30 grains).

In the event of severe bleeding, **rest in bed** is necessary; a piece of rubber tubing of the caliber of the little finger wrapped with **iodoform gauze**, may be introduced for 24 to 36 hours; the gauze may, in addition, be saturated with **coagulants** or **hemostatics**. L. Kuttner (Deut. med. Woch., July 18, 1924).

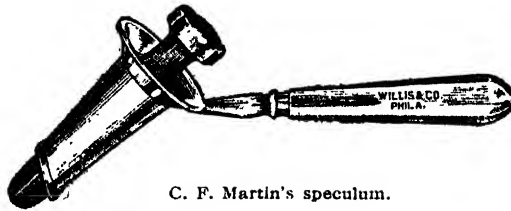
Recalling a note to the same effect by Webber, the author gives internally **pix liquida** (Stockholm tar) with an equal weight of powdered **licorice** in 5-grain (0.3 Gm.) pills, 3 or more to be taken daily. He found this agent almost invariably successful and the improvement so rapid that, as a rule, troublesome symptoms disappeared in a week or 10 days. As far as he knows, relapses and recurrences have not taken place and very few, if any, patients have later required operative intervention. Benham (Lancet, Nov. 8, 1924).

**Operative Treatment.**—The ideal operation for internal hemorrhoids does not exist. Each method must be selected according to the merits of the case, and according to the ability of the operator to properly perform the same. As a rule, every operator obtains the best average results by employing the method in which he is most skilled, departing from his favorite technique only when he sees

some special indication. For this reason, the relative merits of the various operations will not be discussed.

All of the operations so far devised can be placed into one of four classes: the injection treatment; the ligature method; the clamp and cautery operation; and the operation by excision of the pile-bearing area, originated by Whitehead. All of these procedures have been modified so many times that one would feel that any one of them must have had some objectionable features to have occasioned so many variations.

first employed by Mitchel, of Clinton, Ill., in 1871. Since then, many imitators, both regular and irregular, have devised innumerable modifications. The technique given below is that devised by my father, the late Dr. Robert W. Martin, in 1893. During the period 1877-93, he experimented with many other substances, such as hot water, the perchloride and persulphate of iron, ergot, hamamelis distillate, and alcohol, with frequent returns to carbolic acid. In 1893, the use of phénol sodique, or, more accurately, a 50 per cent. dilution of the original French phénol



C. F. Martin's speculum.

The **injection treatment** may be employed in those cases where a more radical form of operation has been refused or where it is not desirable to confine the patient to bed, on account of poor health or old age, or even because he may be unable to give up his occupation even for the short time required by the more formal operations. In properly selected cases the results compare favorably with the ligature and the clamp and cautery operations. Carefully used, the dangers are no greater than with other methods, but it must be remembered that just as much care as to technique and asepsis must be used as in any operation about the rectum. External piles should never be treated by this method.

The **injection of carbolic acid** for the relief of internal hemorrhoids was

Bobœuf, displaced all other forms of solution.

Briefly, the method may be described as follows: The sphincter muscles should first be divulsed under nitrous oxide anesthesia. This is done to prevent the unpleasant symptoms which will follow should a slough develop. Sloughing is also less likely to occur where the muscular irritability has thus been lessened. After three or four days an injection should be made into the largest pile. The tumors should not be protruded for this, but should be injected while in the rectal ampulla. This may best be done through a speculum, the small conical instrument used by him being the most convenient. The needle is inserted into the most prominent portion of the pile and from 5 to 10 minims (0.3 to 0.6 c.c.) of the solu-

tion is injected into the submucosa. The speculum should be removed before withdrawing the needle, thus preventing the backflow of solution which may be occasioned by the pressure of the speculum on the rectal wall. The solution used is a 50 per cent. dilution of phénol Bobœuf in water, but any other of the standard solutions may be tried.

The treatments are given at intervals of from three days to a week, depending upon the sensitiveness of the patient. After an injection a suppository containing 3 minims (0.2 c.c.) of **ichthyol**, is inserted. The patient should also be directed to insert one of these suppositories every night upon retiring.

Only one tumor is injected at a time and, should a slough develop, it should be cauterized with a strong solution or the pure stick of **nitrate of silver**. The acute inflammation is allowed to subside before continuing the treatment. The pain, even when a slough is present, is not severe, the patient simply complaining of a sense of fullness and a slight ache in the rectum.

**Injection of 5 per cent. quinine and urea hydrochloride** solution was used as an ambulatory treatment by the writer in 206 out of 285 cases treated. Using the Brinkerhof speculum, he swabs the surface with **tincture of iodine** and injects about 1 c.c. (16 minims) of the quinine solution into the center of the pile near its base. This procedure is repeated every 3 or 4 days until the tumors have disappeared.

Often a single injection will check bleeding. In inflamed, irritable lesions, with the muscles tightly contracted, **excision** is preferable. Terrell (*Internat. Jour. of Surg.*, Jan., 1922).

Series of 130 cases treated by **injection of 96 per cent. alcohol** in amounts

not exceeding 0.5 to 1 c.c. (8 to 16 minims). The method is used chiefly for *internal piles*, and is employed for intra-anal piles only when they are soft and thin-walled. The piles are first brought down with a **Bier suction glass** under local anesthesia, the glass being left on until the nodules are distended to the utmost and fail to collapse when it is removed. All the piles are injected at 1 sitting, beginning with the smallest and taking care to have no alcohol on the needle point when the nodule is pierced. The piles are reduced *at once* after all have been injected, being smeared with **liquid petrolatum**. To insure aseptic thrombosis, the patient *must* stay in bed for 4 or 5 days on a liquid diet. The method is not suitable for ambulatory treatment. There were 6 recurrences in the 130 cases. Boas (*Med. Klin.*, June 11, 1922).

Internal hemorrhoids of the 2d and 3d degrees are treated by the writer by the injection of a solution composed of 95 per cent. **phenol**, 1 part; **glycerin**, 3 parts, and water, 4 parts. From 2 to 6 drops, according to the size of the hemorrhoid, are injected into the center of each tumor with a hypodermic syringe, using a sharp 24-gauge needle. But 2 tumors are injected at 1 time. One week should elapse before other tumors are injected. Although little pain follows, there develops considerable swelling of the injected hemorrhoid.

When the hemorrhoid is not very large, the patient may go about his work next day. But usually it is necessary for him to remain in bed for 1 to 3 days. Pruitt (*Med. Assoc. Jour. of Ga.*, Apr., 1923).

**Alcohol injections** are effective, but the patients having suffered severe pain, the author prefers injections of 3 to 5 c.c. (48 to 80 minims) of 5 per cent. **quinine and urea hydrochloride** once a week, which he has used regularly for several years in the treatment of a large number of cases. The injections are made only in the submucous cellular tissue at the base of the hemorrhoid. They produce a local

edema and later a fibrosis which hinders the venous circulation. Usually from 6 to 10 injections are required. The anesthetic effect persists for several days. Bensaude (*Bull. Soc. méd. des hôp. de Paris*, May 11, 1923).

If cases be properly selected and proper technique followed the injection method is painless and so little crippling that time is not lost from ordinary vocations. The writer injects into the upper part of the pile, about  $\frac{1}{2}$  to 1 inch above the anal valves or papillæ.

Usually only 1 or 2 piles are injected at a single sitting. The number of injections in each pile varies usually 2 to 4 being required. The literature shows that in the past fully 75 per cent. of all those using phenol solutions for injection were using them much too strong. With 20 per cent. phenol one can not at any time be sure of avoiding sloughing.

The best solution is 10 per cent. phenol in equal parts of glycerin and distilled water. With this solution no pain, hemorrhage, sloughing, ulceration or abscess formation should be expected to occur. H. G. Anderson (*Practitioner*, Dec., 1924).

The writer does not favor the injection of phenol as often used, because it tends to induce extensive sloughing. Quinine and urea hydrochloride in 5 to 10 per cent. solution is now being most commonly used. It is non-toxic and causes less pain than phenol. He has used the non-surgical methods in 1200 cases, with uniformly good results and no deaths. W. A. Fansler (*Minn. Med.*, Nov., 1924).

The injection method as employed by him the writer regards as both simple and absolutely safe. Two sizes of the Brinkerhoff sliding-door speculum and a long gold-pointed needle with a guard, very similar to a tonsil needle, are used. He injects high—about 2 inches up—5 to 15 minims (0.3 to 1 c.c.) of 5 to 9 per cent. solutions of quinine and urea hydrochloride, or a 95 per cent. alcohol solution, or an 8 per cent. phenol solution with 2 per

cent. alcohol in essential oils. The speculum is inserted on the right side first, with the patient lying in the left Sims position. The sliding door being slowly withdrawn about  $\frac{3}{4}$  inch, the internal pile drops into the space and 5 to 15 minims is injected into the base of the tumor.

This procedure is repeated on the left, front and back.

The injections are repeated at 5 to 7 day intervals at least 4 times and the patient then instructed to return within 2 to 4 weeks, when further injections are made if required. The writer used the phenol-alcohol solution in 60 per cent. of 300 cases treated, the quinine and urea solution in 30 per cent., and the alcohol in 10 per cent. The varicose or venous type of piles calls for a 9 per cent. quinine and urea solution for its anesthetic effect. The capillary type responds best to alcohol injections, while the mixed internal-external type does best under an alternating treatment—first phenol, next quinine, then alcohol. For this last type anesthesia with procaine or eucaine is usually advisable. Only very slight discomforts were reported by the patients treated by this method. T. Brockman (*Jour. So. Carol. Med. Assoc.*, Oct., 1924).

The Bensaude technic, involving the use of quinine and urea hydrochloride, is endorsed by the writer. In only 4 of 223 cases was the treatment contraindicated. Out of 547 injections made, an inflammatory reaction with pain occurred in only 6. Sodré (*Brazil-med.*, Sept. 12, 1925).

The ligature operation, for internal hemorrhoids, has many warm admirers, and inseparably connected with it are the names of the late Mr. Allingham, of London, and of Dr. Mathews, of this country. In this operation, after first gently divulsing the sphincter muscles, the piles are seized, one at a time, and dragged down outside of the anal orifice. A "U-shaped" incision is made through

the tegument, just below the base of the pile. This incision preferably should be made just below the anorectal line and above the "white line" of Hilton. The vertical portions of this incision are carried upward on either side of the pile. As the pile is lifted up off the muscular coat of the rectum, the dissection is carried upward under its base, thus forming a pedicle, composed of a narrow strip of mucosa and submucosa, carrying the varicose veins. A fine, strong linen ligature is either thrown around this pedicle, and tightly tied, or else the pedicle is transfixed with a needle carrying a double ligature, and the tissue ligated in two parts. The redundant tissue of the pile is now trimmed off, leaving just enough of a stump to prevent the ligature from slipping. After all of the tumors have been thus removed, a pad is placed over the anal region, this pad being held in place by a tight binder. The anus may first be dusted with some mild antiseptic powder or the pad may be moistened with a saturated solution of **boric acid**. Much of the postoperative comfort of the patient depends upon the separation of the hemorrhoid from the skin of the anus below, and in making the pedicle as thin as possible, so that too much tissue will not have to be cut through by the ligature.

If there should be much postoperative pain, this may be relieved by the administration of **morphine** hypodermically. A suppository of opium should not be inserted, as there may be no occasion for the use of any opiate. Should retention of urine occur, catheterization may be necessary. The bowels should be moved freely on the third or fourth day, by

the administration of sufficient laxative to overcome the extreme spasm of the sphincters which is usually present. The use of opium, other than to control pain, is unnecessary, for the inhibitory mechanism concerned in defecation is working overtime, a laxative being necessary before a movement of the bowels can be obtained. After the bowels have been opened, much swelling of the folds of skin of the anus nearly always follows. After a few days this will subside, often leaving small tags of skin at the anal margin. Should these folds produce any annoyance to the patient, they may be removed subsequently, under local anesthesia.

Of the methods of operative procedure in hemorrhoids the author prefers the **ligature**. Few instruments are required and the operation can be performed in a few minutes and is rarely attended with profuse bleeding or post-operative complications.

The **clamp and cautery** method is especially useful in the treatment of internal piles.

The **excision** method is used in very large external piles.

The **Whitehead operation** should be used only in a few selected cases, and then by a skilled operator.

There are 2 possible routes for regional anesthesia, the **sacral block** and the **anorectal field block**. In the former, anesthesia does not set in satisfactorily for 15 minutes.

The ano-rectal field block is instituted by introducing **procaine** around the lower segment of the rectum. Two to 4 small wheals are first made about 2 cm. ( $\frac{1}{2}$  inch) from the hemorrhoids. Through them a 5 cm. (2 inch) flexible needle is introduced and a circular injection made under the integument. Then a 10 cm. (4 inch) flexible needle is introduced and passed along the inner aspect of the sphincter muscle, the fluid being meanwhile injected, with a finger in the rectum



sensing the amount of solution introduced by the submucous bulging. About 50 to 80 c.c. of 0.5 to 0.7 per cent. procaine solution are required, with 2 or 3 drops of **adrenalin** added to each 10 c.c. The anesthesia should be complete in about 10 minutes. S. H. Graves (Va. Med. Mthly., Mar., 1924).

**The clamp and cautery operation**, popularized by Henry Smith, in 1861, has had many ardent followers, both in our country and abroad. In the hands of the average operator, this method has produced radical results, and has been followed by few unpleasant sequelæ. After divulsion of the sphincters, the hemorrhoids should be drawn down, and the same division, between the skin and mucous membrane, should be made as in the ligature operation, and the clamp should be applied to the pedicle, in the long axis of the bowel. The projecting pile should then be trimmed off with the scissors, leaving sufficient tissue to be cooked by the cautery. The **Paquelin cautery**, the **electro-cautery**, or even an ordinary soldering iron may be employed at this stage of the operation. The stump, grasped in the clamp, should be cooked thoroughly, with the cautery at a dull red heat. A white heat produces excessive charring of the tissues, which are apt to separate prematurely, causing alarming hemorrhage. A piece of wet gauze, twisted about the pedicle of the pile, under the clamp, will prevent any undue radiation of heat, resulting in scorching of the anal skin, or in the destruction of the tissue below the clamp.

Stricture following this operation is due not so much to the placing of the clamp across the long axis of the

gut as to the excessive cooking of the tissues beneath the clamp, causing wide and deep sloughs. If too much mucous membrane is included in the grasp of the clamp, and if four or five such burns are made, almost the entire lower inch of the rectum may be denuded before we are aware of the fact. Care should be taken not to scorch or burn the anal skin, as the resulting condition causes the patient much unnecessary pain. Properly performed, the operation is followed by little pain, and retention of urine is infrequent.

After operation the anal region is covered with a pad of gauze saturated either with a **solution of bicarbonate of soda** or of **boric acid**. These pads should be changed as often as they become soiled. The bowels should be opened on the third or fourth day following operation. After the fifth day, the attending physician should insert the lubricated forefinger into the rectal ampulla, to see that the anal canal is patulous, as a too extensive denudation may result in some adhesion of the raw surfaces, producing narrowing of the anal orifice.

At the time of operation, any hypertrophied skin folds should be removed with the scissors before the sphincters are divulsed, for after the divulsion the protrusion of the internal hemorrhoids is followed by the formation of a revoluted fold of the skin lining the anal canal, which is often mistaken for external piles. The too free removal of this skin fold is apt to be followed by some stenosis of the anal canal. Following operation, particularly after the first bowel movement, considerable swelling of the anal skin occurs, which, on subsiding, leaves more or less irregularity of the anal

margin. These folds may be removed subsequently under local anesthesia.

The **excision** of internal hemorrhoids, originated by Whitehead, and slightly modified by Tuttle, has as its object the removal of the entire pile-bearing area of the rectum. The technique is based upon the two important facts that internal hemorrhoids involve only the lower inch of the rectum, and that the veins of the hemorrhoidal plexus are more firmly attached to the mucosa than they are to the muscular coat of the bowel. Tuttle's operation, for practical purposes, may be divided into three stages: In the first stage, after the sphincters have been divulsed, a small incision is made posteriorly, just between the skin and mucosa at the anorectal line. A pair of blunt scissors, curved on the flat, is closed and pushed up under the mucosa. Using the closed scissors as a blunt dissector, the rectal mucous membrane is separated from the muscular wall, as far as the upper limit of the piles. The mucosa is stripped off, just as one would peel an orange, out of the skin, the veins remaining attached to it. Anteriorly, in the median line, the mucosa is slightly more adherent, but, with care, can be loosened. In the second stage, after the mucosa has been detached, the scissors are withdrawn, and one blade introduced into the incision. The tissue is carefully divided, at the anorectal line, completely around the anus. The blood-vessels at this point are usually small and little bleeding occurs. In the last stage of the operation, the entire cuff of loosened mucous membrane, containing the pathologic veins, is pulled down outside of the anal canal. This cuff is split longitudinally, in the

posterior median line, up to the superior level of the hemorrhoids. A retaining-suture, of heavy catgut, is placed at the upper angle of this incision, fastening the mucosa to the skin below. From this point the mucous membrane is divided, the incision being carried completely around the bowel. Only a short cut is made at a time, the mucosa being sutured to the skin as the operation progresses. After the line of suture has been carried half way around the bowel, to the anterior commissure, a new suture is started at the posterior commissure, but carried in the opposite direction, until it meets the first suture, anteriorly. This is done to obtain a more uniform apposition of the line of suture. This suture is simply a running stitch. If at any point in the sewing, a vessel bleeds too freely, the suture can simply be carried back around the bleeding point, thus effectually ligating the vessel.

If care be taken not to make too long an incision in the mucosa at one time, little trouble will be experienced with hemorrhage.

After the operation is completed, a rubber-covered plug is inserted into the anal canal, its purpose being to obliterate the dead space left below the mucosa and to prevent oozing from the wound. These pressure-plugs are made with a drainage-tube passing through them, to allow the escape of flatus. A firm pad is placed over the anal region. This pad is perforated to allow the tube to project, and is held in place by a tight "T-bandage." The plug may be removed and the bowels evacuated on the fourth or fifth day following operation.

As specified by Anderson, the **Whitehead operation** is indicated only (1) when there is a general hemorrhoidal condition involving the whole circumference of the anal canal, and especially if there is a good deal of prolapse, and also in cases in which there is extensive thrombosis; (2) in cases in which, though the piles may not be large, the anal valves are enlarged, and little blind, submucous pockets may be found running for a varying length upward or downward toward the anus.

Van Hook has advocated, as the simplest operative procedure for hemorrhoids, an **excision** of the masses by oval incisions with their axes parallel to the sphincter muscle. The latter need not be injured. The incisions are carefully closed with many interrupted catgut sutures and heavy zinc oxide ointment applied.

The writer describes an operation suitable in the same cases as Whitehead's operation, but almost bloodless, and less liable to complications. After dilatation, a silk suture is passed at junction of skin and mucosa in the midperineal line, and one on either side of the anus. When traction is made on all 3 the extruded mucosa is triangular. The sides of the triangle are successively clamped and dealt with. Two Hagedorn needles are threaded at either end of a silk suture. The first stitch is placed at the apex of the triangle and tied at the center of the thread. The clamp being removed, the 2 needles are passed through from opposite sides at the same points (cobbler's stitch). Each stitch is pulled taut but not tied. The suture is continued at  $\frac{1}{4}$  inch intervals until the lower end of this side of the triangle is reached, where it is tied. The redundant tissue is clipped away  $\frac{1}{16}$  inch from the line of suture, and the narrow ridge thus left lightly touched with the thermocautery. The other 2 sides of the triangle are similarly treated. In 21 cases this operation gave satisfactory results. F. M. Bell (Brit. Med. Jour., Mar. 18, 1916).

If primary union takes place, the results are ideal, but should the

suture line become infected, or pull apart, more or less stenosis of the parts may result. Care must be exercised not to remove any of the anal skin, for if too much is taken off, the anus will be lined with mucosa. This will produce a condition in which there is constant moisture of the anus, from the escape of rectal mucus. This is extremely annoying to the patient, and at times may necessitate another operation for its relief.

Some disturbances of the anal sensations and a few cases of fecal incontinence have been reported following this operation. In all probability, the too free removal of the anal skin accounts for the sensory disturbances. The fecal incontinence probably depends upon some fault in innervation, such as is seen in tabes.

Of 185 cases in which Stone resorted to **Whitehead's operation**, the results (traced after intervals exceeding 5 years in 154 of the cases), were perfect in every respect in 134 cases, a percentage of 72.4. The most frequent untoward result was disturbance of sphincter action, leading either to weakness of or imperfect control of the bowel. In many cases, however, the patient was inconvenienced only upon medication or indiscretion in diet, which caused an attack of diarrhea. In 16 cases itching and moisture were persistently complained of, and in 5 there was a certain degree of stricture. In 14 a recurrence in some measure had taken place.

The writer recommends a **simplified local anesthesia** for operation in anal fissure and hemorrhoids, which he has used with perfect satisfaction in over 100 cases. As anesthetic he employs the Schleich **cocaine mixture**. For stretching the sphincter, only 5 c.c. is required. The single puncture is made exactly in the posterior midline, 2 fingerbreadths from the anal margin. At this point, with a thin needle 6 cm. long, at first 1 drop is injected intradermally and then the balance is in-

jected in part tangentially toward the sphincter and in it, and in part intracutaneously and subcutaneously toward the anal margin. Anesthesia is accomplished at once and is complete. For the cauterization of hemorrhoids, if the nodules are external or can be pressed out, he injects from 3 to 5 c.c. of the solution into each nodule in succession. Each nodule must be injected and cauterized before proceeding with the next. If the hemorrhoids are internal, the sphincter must be dilated, and the nodules are then injected and cauterized 1 by 1 as in the case of the external hemorrhoids. Philipowicz (Jour. Amer. Med. Assoc., from Zent. f. Chir., June 16, 1923).

The clamp and cautery is the safest method, and no other comes as near being a radical procedure except the Whitehead, which the writer does not favor. The clamp and cautery is least painful, with an easy, rapid convalescence. It should be given preference whenever the patient can afford to spend 2 or 3 days in bed. It has been open to the objection that a general anesthetic was required. To meet this drawback he has used **sacral anesthesia** in 64 of his 600 cases, with successful anesthesia in 61. He injects 30 c.c. (1 ounce) of 1.25 per cent. procaine solution into the sacral canal from between the 2 cornua or tubercles at the hiatus sacralis. (There was 1 death, from ether pneumonia, in the 600 cases. Parker Syme (Surg., Gyn. and Obst., Sept., 1924).

Electric methods have by some been applied to the radical treatment of hemorrhoids.

The writer treats hemorrhoids and anal fissures by **desiccation**, i.e., by heat generated with the high frequency current, applied with a needle. In small hemorrhoids the needle is not brought in actual contact with the pile, but merely close to it. Post-operative discomfort is asserted to be slight, and stenosis, embolism and secondary hemorrhage are avoided. W. L. Clark (Amer. Jour. of Electroth. and Radiol., June, 1921).

In internal hemorrhoids, the author uses **electrolysis**, an ordinary cambric needle being inserted  $\frac{1}{4}$  inch into the tip of each pile at a separate sitting, under quinine and urea or procaine anesthesia. The negative pole is attached to a large moist pad strapped to the abdomen. A 10 or 15 ma. current is used until the pile becomes decidedly blanched or ashy. Sigmond (Amer. Jour. of Electroth. and Radiol., June, 1921).

Whereas in over 20 of the authors' 103 patients operative treatment did not afford permanent relief, a definite cure by **electrocoagulation** is stated to have been obtained in nearly all. Piga and Freixinet (Rev. Ibero-Amer. de Med., Sept., 1924).

After any operation upon the rectum, should *infection* or *hemorrhage* occur, the patient should be anesthetized immediately, and the condition appropriately dealt with. Packing of the rectum for hemorrhage, except as an emergency, is a blind operation at the best, and is very painful to the patient. It is better to anesthetize the patient, and search for and tie the bleeding vessels.

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**HENBANE.** See HYOSCYAMUS.

**HENPUE.** See GOUNDOU.

**HEREDITARY ATAXIA.** See SPINAL CORD, DISEASES OF.

**HERNIA.—DEFINITION.**—The term hernia is used to denote the protrusion of one or more of the abdominal viscera, and is synonymous with the ordinary term "rupture."

**VARIETIES.**—If the protrusion occurs through openings in the abdominal wall which, normally patent in fetal life, through some defect in development have failed to close at birth, the hernia is said to be *congenital*. The protrusion usually occurs at

points in the abdominal wall by nature weaker than elsewhere, viz., in the femoral region, in the inguinal canal, and at the umbilicus. If the protrusion takes place through an opening not present at birth or in a sac that has developed since birth it is called an *acquired* hernia. Within the last two decades, with a greatly increased knowledge of hernia due to the very large number of operations for radical cure, we have learned that nearly all hernias are really congenital, that is, the sac or funicular process of peritoneum is of prenatal origin. The experimented studies on the cadaver by Murray, of Liverpool, still further confirm this belief.

In addition to the varieties above mentioned there may occur ventral hernia following abdominal incisions or accidental wounds. This variety is frequently known as traumatic hernia. A hernia takes its name from the site of the opening through which it protrudes. The common forms are: *inguinal*, *femoral*, *umbilical*, and *ventral*. The rare forms are: *diaphragmatic*, *lumbar*, *obturator*, *ischiatric*, *pubendal*, *perineal*, *propritoncal*, and *retroperitoneal*.

Distinction is made by some surgeons between *external* hernia, including all the varieties above mentioned, and *internal* hernia, by which latter is meant the protrusion of a viscus through some anomalous pouch in the peritoneum.

From 1891 to 1918 there were treated by radical operation at the Hospital for Ruptured and Crippled, New York City, 8589 patients. The mortality statistics have changed but little. The first ten years it was .22 per cent., while during the third decade it was .15 per cent. Coley and Hoguet (*Annals of Surg.*, Sept., 1918).

**SURGICAL ANATOMY.**—A hernia consists of a sac, the coverings of the sac, and contents. The sac is always a prolongation of the parietal peritoneum; it varies in size and shape according to the stage of the hernia. At first it is merely a pouting or bulging into the hernial orifice, narrow at the end and wide at the base. As the hernia extends and emerges from the orifice, the sac is elongated, and from the pressure of the contents the lower portion becomes globular or pyriform in shape. The narrowest part of the sac is called the *neck*, and the external, or distal, portion is called the *fundus*. A sac formed in this way—namely, by a gradual pushing forward of the parietal peritoneum—is said to be acquired, while a congenital sac is preformed, the protrusion occurring in the open tunica vaginalis or through the patent navel. A congenital hernia, while it may appear late in life, is dependent upon conditions which existed at birth.

Adhesions may occur between the sac and its contents. The sac may become greatly thickened and opaque,—usually owing to the irritation of an ill-fitting truss,—and may undergo calcareous or malignant degeneration. Certain hernias are said to have no sac,—as, for instance, hernia of the bladder, sigmoid flexure, or cecum. This is not entirely true; a sac exists, but the peritoneum does not completely surround the viscus.

The coverings of the sac are made up of the different layers of tissue outside of it. These, of course, vary according to the site of the hernia. It is very necessary that the surgeon who operates on hernias should have an accurate knowledge of these layers,

owing to the great importance given to modern methods for radical cure.

Every viscus, except the pancreas, has been found in some variety of hernia. The contents are usually made up either of intestine or omentum, or both. If the hernia is reducible, the bowel and omentum present a normal appearance; but if irreducible, and the hernia of long duration, numerous pathological changes are likely to occur. The omentum becomes thickened and adherent to the sac, usually at the neck, or to the bowel, if that be present. A small amount of serous exudate is not infrequently present in an irreducible hernia.

If the hernia contains omentum alone, it is called an *epiplocele*; if bowel alone, an *enteroccele*; if both are present, *enteroepiplocele*.

[In about 700 operations for hernia in the female, the ovary was found herniated alone in 4 cases, the tube alone in 1 case, the tube and ovary in 7 cases, and the uterus and tube in 2 cases. Hilgenreiner was able to find reported but 37 cases of hernia of the uterus, and his statistics showed it to have occurred most frequently in middle-aged women who had borne children. In nearly one-half of the cases reported the trouble was associated with defects and malformations of the genital organs. The diagnosis is seldom made before operation except in cases complicated with pregnancy. WILLIAM B COLEY.]

In Coley and Hoguet's 6776 operations for hernia, there was hernia of the bladder in 17 instances. The writer recognizes the following varieties of bladder hernia: (1) Intra-peritoneal, in which the bladder is completely surrounded by peritoneal sac; (2) para-peritoneal, in which it is partly surrounded by peritoneal sac, which may in some instances be very small; (3) extra-peritoneal, in which the bladder has no relation to a peritoneal sac because there is none. Extra-peritoneal

inguinal hernia of the bladder is infrequent, and occurs mostly between the 3d and 5th decades, in the male, and on the right side. The writer collected 61 such cases. Bladder symptoms and incarceration are absent in the majority of instances. Prevesical fat is invariably present and, by traction, probably plays a major rôle in extra-peritoneal inguinal bladder diverticulum. There is no question that some bladder hernias are congenital. L. Carp (Surg., Gyn. and Obst., Oct., 1924).

Case of incarceration of the bladder in the femoral ring. An old woman had symptoms suggestive of a strangulated epiplocele or partially strangulated intestinal hernia. At operation a seeming hernial sac was exposed and opened, but proved to be the bladder, urine spurting out. The real hernial sac, small and empty, was found beside it. The bladder was sutured in 2 layers and reduced with some difficulty after incision of Gimbernat's ligament. S. Laskownicki (Jour. d'urolog., Sept., 1924).

Case of congenital hernia of the funicular type in which the cecum was found herniated. This was accounted for by the existence of an ascending mesocolon with elongation of the mesocecum, thus allowing the cecum to enter a left oblique inguinal hernia. Kau (Nat. Med. Jour. of China, June, 1925).

**ETIOLOGY.**—About 25 per cent. of persons with a hernia give a family history of it. While 40 per cent. develop hernia before the age of 35, 60 per cent. of the cases occur after that age.

The occupation is an important factor in causing hernia. Those trades requiring the most severe muscular effort having the highest proportion of persons ruptured. The increased liability to muscular strain in men is undoubtedly an important factor in explaining the greater proportion of

ruptures in male than in female subjects. Parturition is a frequent cause in the female, especially of umbilical hernia.

Anything that tends to weaken the abdominal walls may be the indirect cause of hernia; for example, traumatism followed by the formation of cicatricial tissue, contusions, obesity, ascites.

The chief exciting cause of hernia is a sudden strain; the larger proportion of hernias, especially in adult life, come on soon after some unusual effort. The hernia generally begins with a slight fullness over the canal, often associated with a little soreness or feeling of discomfort. In rare cases a fully developed hernia may immediately follow sudden strain.

The New York State Compensation Board considers true traumatic hernia to be a very rare condition. As shown in 5000 new cases, there is no basis in fact that a recent hernia is tender and painful on manipulation and accompanied by ecchymosis. The nature of the sac often proves the congenital origin of the hernia; its contents, such as omentum and bowel, often indicate the cause of the pain. A single strain can never cause a hernia, but one may develop from the cumulative effect of a great many strains over a long period of time. Coley, Leigh, Walker, Hopkins and Hutchinson (*Ann. of Surg.*, Apr., 1922).

Great confusion still exists in the minds of the laity and legal profession on the subject of industrial or traumatic hernia. The term "rupture," used in many of the earlier text-books, is partly responsible for this, leading to the assumption of a tear, which must have been the result of an accident. The decisions in the English courts for the last century are also responsible; these courts floundered among contradictory medical witnesses and did not have the benefit of sound scientific teaching which has been pos-

sible since hernia operations have become more common.

Many surgeons believe that practically no hernias are of traumatic origin and that they should not be compensated.

The writer divides hernias of effort into 2 types: (1) Hernias alleged to be due to muscular effort and appearing suddenly and immediately, under adequate and convincing circumstances; (2) hernias appearing gradually shortly or remotely after trivial effort and under inadequate and unconvincing circumstances.

Real cases of the first type will occasionally be met.

Thus, if a man can reasonably establish that he had no hernia before a certain episode; if this episode was accompanied by a sufficient muscular effort to make possible the stretching and tearing of muscles, fascia and aponeurosis, previously intact; if the immediate results are those that any medical man or intelligent laymen must realize would have to be, then a compensable hernia has been produced. In such a case, as Coley has stated, it is immaterial whether a previously empty preformed sac was present or not.

The 2d type of cases are the more numerous, and are exactly those in which there is always a congenital sac. The hernia has been forming slowly for months or years, painlessly and without the claimant being aware of it. The most trivial muscular efforts, coughing, sneezing and strains at defecation have been helping to dilate the internal ring, spread open the persistent process and force intestine or omentum into the congenital sac. A hernia will come anyway at some time, work or no work. The final strain merely calls the man's attention to his groin, and cannot logically be held to be the cause of the hernia. J. M. Wainwright (*Arch. of Surg.*, Mar., 1923).

It is the general opinion that of 1000 cases of hernia, only 2 or 3 can be actually regarded as industrial accidents. The author's experience with

65 cases would support approximately some such ratio. Only exceptionally can a hernia be ascribed to physical injury; nearly always it develops slowly in a person congenitally predisposed to it. The trauma is not the cause, but merely aggravates the preëxisting lesion. The problem would be solved by insistence upon a physical examination of all workers before employment. L. Ribeiro (Brazil-med., Nov. 28, 1925).

The great increase in our knowledge of hernia of late has tended to prove that the most important and most frequent cause is the presence of a congenital or preformed sac. This preformed sac is present in practically all oblique hernias and in many direct and femoral hernias. The open funicular process of peritoneum is thus the actual and important cause of nearly all hernias, and the sudden strain, fall, or unusual effort is merely the secondary cause, forcing a piece of bowel or omentum into a pouch that already existed.

In a careful post-mortem examination on 200 bodies, nearly all adults, without any history of hernia during life, Murray found in 47 individuals, 30 males and 17 females, 68 peritoneal diverticula, or potential hernia sacs. In 16 instances more than one diverticulum was found. Fifty-eight of these diverticula were in the femoral, the remainder in the inguinal canal.

According to Hessert, in fully  $\frac{3}{4}$  of the cases of oblique inguinal hernia the chief etiological factor is a congenital sac, the result of faulty closure of a part or the whole of the vaginal process. While it is not possible in many cases to make a positive diagnosis of a congenital sac, the following points are suggestive: (1) Glove-finger-like and narrow sac, generally empty; (2) thin wall; (3) absence of subserous fat; (4) trabeculated structure; (5) annular con-

strictions which often still correspond with the internal or external ring, though frequently the constriction has been displaced beyond the ring; (6) thickening of fundus; (7) fibrous process extending downward from fundus for a variable distance, sometimes attaching to the tunica vaginalis testis; (8) close relationship of sac to vas deferens and spermatic vessels which may be spread over it; (9) sac still enveloped by fibers of the cremaster muscle.

The preformed sacs of inguinal hernia are usually not demonstrable in the living subject.

In a series of cases in which the inguinal canal was opened on account of a relaxed ring and in which no clinical evidence of hernia was seen, in every instance a small persistent sac was found.

Analysis of a group of cases showed that 16 per cent. of individuals presenting hernia on one side eventually develop hernia on the opposite side.

Correlation of these facts lends further support to the preformed sac theory in regard to the etiology of all inguinal hernias. Hughson (Surg., Gyn. and Obst., Nov., 1925).

Careful examination of inguinal hernias reveals many with 2 sacs—an indirect thin-walled sac and a direct fatty sac. In 4 years, 9 out of 129 cases of various kinds of hernia showed multiple sacs, mostly in fat persons between the ages of 35 and 50. McQueeney (Ann. of Surg., Jan., 1926).

In 709 cases of inguinal hernia, in the male, in children operated upon at the Hospital for Ruptured and Crippled, the history definitely stated the type of the sac. A congenital sac, *i.e.*, a sac communicating with the tunica vaginalis, was found in 284 cases, while in 425 cases the sac was of the acquired type, having no communication with the tunica vaginalis. This is directly contrary to the view held by most surgical writers. It is probable, however, that in the great



majority of cases of so-called acquired sac there is a preformed sac, existing since birth, though not communicating with the abdominal cavity.

Indirect causes of hernia are chronic bronchitis, pulmonary affections in general, and habitual constipation.

In oblique inguinal hernia in infants the writer makes a small incision 1 inch over the external abdominal ring, raises the cord with the finger, and makes an incision, through its coats, intercolumnar, cremasteric, and transversalic. He separates the sac well, especially above; draws down after opening it, transfixes and ties off. The reduced portion is cut off and allowed to retract up the canal. If it is a congenital case, he merely ties off the sac above the testicle and below at the external ring; a few horse-hair stitches are all that is required. If the sac is not found beneath the external ring, he cuts the aponeurosis of the external oblique. This is then sutured with catgut. The patient should be on his back for 2 or 3 weeks. A truss may be worn afterward if there is much coughing or vomiting. With this operation little catgut is left in the wound to cause trouble. W. A. Robertson (West. M. News, ix, 17, 1917).

### REDUCIBLE HERNIA.

**DIAGNOSIS.**—A reducible hernia usually presents the following signs: A soft tumor or swelling is found in one of the hernial openings. This swelling disappears on lying down, or on moderate pressure; it gives a distinct impulse on coughing, and usually it is seen to increase in size during the act of coughing or straining of the abdominal muscles.

In most cases there is a history of gradual development, with sensations of discomfort in the region of the swelling, especially noted after long standing or walking. In the early

period of development nothing more than a slight fullness may be found; but as the hernia descends it becomes a well-defined tumor. The character of the swelling varies according to the contents of the sac. If it contains bowel alone, it feels smooth and elastic; the impulse on coughing is well marked and reduction is often accompanied by a gurgling sound. Percussion yields a tympanitic note distinctly different from the flat sound produced in omental hernia. If the contents consist of omentum alone, the tumor is more uneven in outline, gives a lobulated feeling and is entirely without elasticity. Both bowel and omentum may be present, in which case there may be a combination of the physical signs already described. Not infrequently the bowel is perfectly reducible, while the omentum is adherent to the sac. The sensations of discomfort and the dragging pain, which may be very slight in a rupture of small size, may become very marked in a large hernia, especially if the latter be not controllable by truss.

Incomplete inguinal hernia is often the cause of pain, sometimes dull and continuous, radiating from the inguinal region to the back, at others more sharp and colicky. Gas, constipation, and a feeling of fullness are also sometimes complained of. Incomplete hernia in the right inguinal canal has been mistaken for recurring attacks of appendicitis; in other cases "neuralgia of the ilio-inguinal or femoral nerve," or neuritis, has been diagnosed.

The small femoral hernia sometimes causes similar symptoms to those just mentioned. If the trouble is allowed to continue, nervous symptoms, headache, fainting, and emaciation may occur. In adults, umbilical hernia always produces gastric disturbances,

sometimes quite serious. Max Ballin (Jour. Mich. State Med. Soc., March, 1908).

The following diagnostic points between recently acquired and chronic hernias are tabulated by Butte:—

RECENTLY ACQUIRED HERNIA.	CHRONIC HERNIA.
Hernia cone-shaped, base pointing inward, and apex outward.	Hernia with apex inward; base globular and pointing outward.
Sac shows good muscular tone.	Sac relaxed, flabby, and later puckered.
Absence of pigmentation.	Presence of pigmentation, due to separation of muscular fibers of sac and resulting stasis in superficial veins.
Ring small, thin, and with uneven edges.	Ring large, with edges thickened and smooth, due to friction (in and out movements of viscus).
No signs of adhesions.	Thickening (adhesions) may be present, due to omental hypertrophy above and below ring.
As a rule rather difficult to reduce, but returns easily.	Reducible spontaneously and returns easily on account of large ring unless adhesions exist.
Presence of acute inflammatory signs (heat, redness, soreness, etc.), due to injured peritoneum and torn muscle fibers.	Only source of inflammation is irritation or inflammation of previously formed adhesions.
Inguinal canal normal in outline.	Inguinal canal displaced.
Absence of truss marks.	Truss marks may be present.
Proper-fitting truss should always hold hernia in place.	Best-fitting truss may not hold hernia up.
Pubic hair not disturbed, as no truss has ever been worn.	Pubic hair worn off and curled up.

**TREATMENT OF REDUCIBLE HERNIA.**—The various methods for the treatment of hernia may be classified as either palliative or operative. Palliative, or mechanical, treatment includes all the various appliances by means of which an effort is made to restrain the contents of the abdomen within the hernial orifice. In the majority of cases mechanical treatment does not aim to close the orifice,

though in children and young adults such a result is often obtained, thus effecting a permanent cure.

**Truss** treatment yields cures in 50 to 75 per cent. of cases of simple inguinal hernia in children under 4 years, and should be tried first whenever possible. Infants under 1 month can wear a **bandage** or **worsted truss**, and later a light spring truss covered with muslin or flannel, with a soft cloth placed between the pad and skin. The best truss for infants and children, however, is a frame truss of phosphor-bronze, which can be applied to an infant a day old. Where a strangulated hernia is only of a few hours' standing, it is sometimes justifiable to attempt reduction by **taxis**, applied very cautiously. If this cannot be effected in a **warm mustard bath** or with **hot compresses**, the following may be helpful: **Slinging the child by the feet**, head down; **elevation of the foot of the bed**, and **flexion and outward rotation of the thigh**. Other indications for **operation** are failure or inapplicability of truss treatment; hydrocele in the inguinal canal; adherent omentum or intestine in the sac; recurrent strangulation; delayed descent of the testicle, or preference by the parents. L. F. Watson (Va. Med. Mthly., Nov., 1924).

For inguinal hernia in young infants the writer recommends an easily changeable **truss** consisting of a triangular pad stuffed with absorbent cotton, to each corner of which is attached a soft muslin tube about  $\frac{1}{2}$  inch in diameter and 6 inches long, likewise stuffed with cotton. The pad is placed over the hernia and one string passed over each iliac crest to be tied behind in the lumbar region. The third string is brought down between the thighs and thence backward, and is tied posteriorly. L. C. Rosenberg (Jour. Amer. Med. Assoc., Aug. 30, 1924).

**Trusses.**—No description need be given of the great variety of trusses. The object to be accomplished by a

truss should be the complete retention of the hernia without causing discomfort to the patient; there are many forms of trusses which fulfill this object satisfactorily. A good truss should consist of a pad to cover the hernial orifice and a spring or band to hold the pad always in the proper position. Steel is, I believe, the best material for this purpose. A spring should surround the pelvis entirely or in part, and should be so constructed as to retain its place either by its own elasticity or by the aid of a strap. The two forms of trusses which I consider to meet best the requirements of an ideal truss are the so-called Knight, or cross-body, truss and the Hood. Both these varieties may be used for single or double truss, and the Knight is quite as satisfactory in femoral as in inguinal hernia. The Hood pattern can be used only in inguinal.

The pad may be made of hard rubber, celluloid, cork, or of wood covered with leather. Some cases not retained by this variety of pad may be satisfactorily controlled by the substitution of a so-called water-pad. These trusses may be made of any size and may be used in the youngest infants without discomfort. In infants and children great care should be taken that the spring be not too strong. The spring itself may be protected by leather, rubber tubing, or hard rubber. In rare cases—for example, emaciated infants—the worsted truss may serve a useful, but temporary, purpose. For routine work it is much inferior to a properly constructed steel truss.

The truss should be so applied that the pad rests over the internal ring rather than upon the pubic bone. In

scrotal hernia it is better to apply the truss in the horizontal position, care being taken that the contents of the rupture be entirely reduced before the truss is put on. In incomplete rupture this is not so important. In infants and young children the truss should be worn both day and night. In adults it may be, in most cases, removed with safety on retiring. Careful attention to the skin beneath the pad is important, especially in children; frequent bathing with alcohol will be found of great service.

One cannot state definitely how long a truss should be worn. It depends largely upon the age of the patient and the size of the rupture. A very large proportion of infants and young children may be cured if treatment is carried out under favorable conditions.

At the Hospital for Ruptured and Crippled a truss is seldom left off in children until a period of two years has elapsed after the last appearance of the rupture. In infants under 1 year of age the truss may be discarded.

There is a certain class of cases in which no form of truss will retain the rupture. This applies to very large scrotal hernias, with openings sufficiently large to admit four or five fingers. These hernias are usually found in middle-aged and elderly people. Operation is in such cases often contraindicated, and the most we are able to do in the way of affording relief is a scrotal bag made of stout material and supported from the shoulders.

The mechanical treatment of umbilical hernia differs with the age of the patient. In infants and young children no form of belt or truss is satisfactory, for the reason that it

seldom retains its place for any length of time. The treatment used at the Hospital for Ruptured and Crippled is to apply a small pad, consisting of a wooden button-mold covered with leather, to the hernial orifice. This is held in place by a strip of rubber plaster two inches in width, which entirely incloses the abdomen. Care should be taken that the plaster be not applied too tightly, and it should be changed at least every ten days. It seldom causes excoriation, and in most cases the rupture will be found to have disappeared at the end of six months or a year. Very few cases go beyond puberty without being cured, and hence the impropriety of operating upon these cases.

### IRREDUCIBLE HERNIA.

Any form of hernia may become irreducible. This condition is, however, more frequently found in umbilical than in any other variety of hernia. It is exceedingly rare in children and young adults, and most frequently found between the ages of 30 and 60. In irreducible hernia the contents are most frequently omentum, omentum alone occurring in 90 per cent. of the cases. Omentum with bowel—enteroepiplocele—occurs next in order of frequency. Enterocoele—bowel alone—may become irreducible with numerous adhesions, but this condition is rare.

Where there is an irreducible inguinal hernia with hard contents and the shape of which suggests the uterus, one should palpate through the vagina to determine whether the uterus is actually involved. Hernia of the uterus is frequently accompanied by malformation of the internal genital organs. If the hernia cannot be reduced, it is best to remove the organ. Cesarean section was

done in 5 cases in which the woman was pregnant; 4 of the mothers died and 1 of the children. In 2 other cases premature delivery was induced, with good results. Cranwell (*Revue de gynéc.*, t. xii, No. 5, 1908).

Where a large irreducible hernia of long standing is finally reduced, serious abdominal distention may follow, with even fatal consequences. If reduction is extremely difficult, it is better to resect a portion of the intestine, up to 3 meters. If this is not done and incarceration results, it may be necessary to remove an even greater portion. Two fatal cases are reported with hernias of 12 and 30 years' standing. Death occurred from congestion of the lungs in 1 case, plus incipient peritonitis in the other. Schönbauer (*Wiener klin. Woch.*, Nov. 6, 1919).

Clinically, irreducible hernia differs but little from reducible hernia, which has already been described, except in the fact that the contents of the sac cannot be replaced in the abdominal cavity.

Persons suffering from this form of hernia are liable to frequent attacks of colic, and are almost always subject to constipation. In this variety of hernia inflammation and strangulation are more likely to occur than in reducible hernia.

**TREATMENT OF IRREDUCIBLE HERNIA.**—If the hernia is not too large and the patient is a good subject for operation, an attempt may be made to effect a radical cure. Mechanical measures are, as a rule, very unsatisfactory. No form of irreducible hernia can be treated with an ordinary truss without much discomfort. A truss fitted with a concave pad often proves satisfactory in irreducible hernia of small size; in umbilical and ventral hernias, a stout abdominal belt with a circular, flat

**pad**, or with a **slightly concave pad** in the hernias of larger size, will furnish all the relief we are able to give for this class of cases.

If the hernia has been down but a few days and there are signs of local inflammation, the patient should be kept in bed for a few days and an **ice-bag** applied. In using an ice-bag in these cases where the vitality of the skin is more or less impaired, one should always see that the ice-bag does not rest directly upon the skin, otherwise serious sloughing may ensue. Gentle **taxis** may be used during the course of this treatment, but it should be of only brief duration and never violent. If the rupture cannot be reduced in one or two weeks, it may be regarded as permanently irreducible, and either operation or suitable mechanical support should be employed according to the nature of the case.

In the case of an infant of 3 months, suffering with an irreducible inguinal hernia for nine hours, the author placed the patient with the buttocks slightly elevated, and blew forcibly into its face. The child stopped crying and the abdomen became relaxed. The blowing was kept up while the hernia was slowly but steadily being replaced by **taxis**, and held in position by a band of adhesive plaster. A. Nussbaum (Munch. med. Woch., July 1, 1913).

In irreducible inguinal and femoral hernia a very large number of patients are good subjects for operative treatment; that is, they are under 50 years of age and the hernia is of moderate size, varying between that of a hen's egg and two fists. The results of operation in these cases are extremely satisfactory, and, as far as my personal experience goes, results have been as good as in reducible hernia

in patients of similar age. On the other hand, not a few cases, especially of umbilical and ventral hernia, are old epiploceles of very large size in very stout women with a great excess of fat in the abdominal walls. In such patients, as well as in those who are weakened by disease of the thoracic or abdominal viscera, operation may not be advisable, our efforts being confined to preventing the rupture from increasing in size. Great improvement in the results has been brought about by the newer methods of operation for umbilical hernia. In particular, the **Mayo overlapping operation** may be advised in many cases which were formerly regarded as inoperable.

### STRANGULATED HERNIA.

The term "strangulated" is applied to an irreducible hernia in which the loop of bowel is so constricted as to prevent the passage of fecal contents and to interfere with the circulation.

The most common causes of strangulation are heavy lifting, severe coughing, and straining. It may also be produced by a blow or a fall.

In irreducible hernia strangulation often results from inflammation or engorgement of the contents of the sac, or from adhesions formed between the sac and its contents.

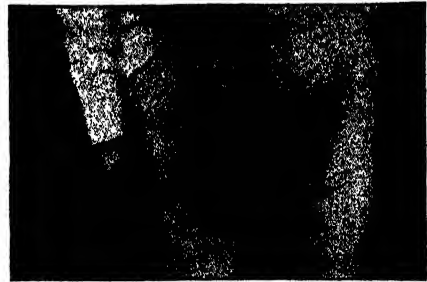
It is unnecessary to mention the various theories that have from time to time been offered in explanation of the way strangulation is brought about. The best and simplest explanation is that of venous engorgement: The walls of the veins being more compressible than the walls of the arteries, blood continues to flow into the imprisoned loop of bowel

long after its return has been cut off. This produces great engorgement and rapid exudation of serum into the hernial sac, which makes reduction more and more difficult. The bowel first becomes of a brighter red, later bluish, then mahogany colored and, finally, just before gangrene sets in, of a dull slate color. The exudate, which at first is clear, after a longer or shorter interval becomes turbid. Gangrene may occur at varying intervals, depending upon the tightness of the constriction, the earliest time within which it has been observed being four hours and the latest two weeks. The fluid in the hernial sac frequently contains bacteria, although in the larger proportion of cases thus far investigated, it has been sterile.

**SYMPTOMS OF STRANGULATED HERNIA.**—The first symptom is usually pain, referred to the irreducible tumor at the site of the hernial orifice. Upon examination the tumor is found tense and very tender on pressure; it gives no impulse, or at most a slight impulse, on coughing. If the strangulation has existed but a short time, the tumor will give a resonant note on percussion. Later this sign may be absent, owing to accumulation of fluid in the hernial sac. In some cases the pain is referred to the umbilicus rather than the hernial tumor.

The writer's 15 cases included 1 with intestinal hemorrhage, and 2 with paralytic occlusion, fatal in 1 case. He condemns all attempts at taxis, and urges immediate incision and evacuation of the contents of the loop if there is the slightest doubt as to its vitality. Pneumonia followed the operation in 3 cases, probably due to the ether plus the septic intoxication. E. Stincer (*Rev. de Med. y Cir. de la Habana*, July 10, 1917).

Case of irreducible femoral hernia in a man aged 57 years, who developed acute pain and tenderness in the groin, with nausea and persistent vomiting and an appreciable increase in the size of the protrusion. Efforts to move the bowels and taxis were fruitless. An incision under nitrous oxide-oxygen and local blocking revealed a loop of black and lifeless gut from which issued a foul, dark fluid containing fecal matter. One end of the loop was wide open and the segment from which it had separated was nowhere to be seen. A liberal incision through the rectus muscle exposed the open, retracted proximal end of the ileum,



Double direct hernia.

gangrenous for a distance of 3 cm. The presenting coils were studded with a fibrinopurulent exudate. Excision was performed and a Murphy button used, uneventful recovery following. The resected segment showed 2 small ulcerations. Thus, in strangulated hernia, there must be added to shock due to the intestinal block the possibility of rupture from pressure necrosis or of ulceration as mortality factors. F. LeM. Hupp (*Ann. of Surg.*, Oct., 1924).

Of all the symptoms encountered in strangulated hernia, vomiting is the most important. Vomiting is always persistent, occurring at longer or shorter intervals. At first the vomitus consists merely of the contents of the stomach; if the hernia is not reduced, it contains bile, mucus, and finally becomes stercoraceous. Com-

plete constipation is always a symptom of great importance. In rare cases diarrhea may occur as an early symptom. There is always an increase in the pulse rate and usually a slight elevation of temperature, especially in the early cases. Later on the temperature may become subnormal.

In acute inflammation of the appendix in a strangulated hernia in children under 6 years it has been the author's observation that the febrile reaction is usually in inverse proportion to the intensity of the inflammation present. This is an important point, since the absence of fever may lead one to temporize, often with fatal results. A boy of 2 years had a large swelling in the scrotum and right inguinal region. He appeared very sick and was vomiting frequently. The pulse was rapid and of good volume, the temperature normal and the abdomen slightly distended. As the hernia could not be reduced, immediate operation was advised. Some firm adhesions at the neck of the sac, preventing reduction, were separated. The contents of the sac proved to be a long cecum with a large, thickened, acutely inflamed appendix. This inflammation was regarded as secondary, having been induced by trauma and bascular distention due to incarceration. V. A. Lapenta (Jour. Amer. Med. Assoc., Nov. 24, 1923).

*Hernias of the intestinal wall, i.e., hernias in which only a portion of the circumference of the bowel protrudes into the hernial ring, are peculiar in being almost without symptoms. There is often merely slight pain in a hernial tumor frequently scarcely palpable. Such hernias were formerly considered rare, but some observers have met them with relative frequency. The large intestine is seldom concerned, but in the author's case, in a woman of 75, whose small tumor in the left groin had become irreducible after a coughing spell and who was operated under local anesthesia 48*

*hours after incarceration, irreparable injury of the tissues about the segment of sigmoid involved was found, and a fistula was established. H. Knoté (Deut. Zeit. f. Chir., Oct., 1924).*

In strangulated omental hernia with strangulation of omentum alone—an extremely rare condition—all of the symptoms are milder in character. Constipation may or may not exist.

[I have observed one case of acute strangulated omental hernia in which operation was performed on the third day. WILLIAM B. COLEY.]

**DIAGNOSIS OF STRANGULATED HERNIA.**—There is no condition likely to be met with in surgical practice in which it is more important to make an early and correct diagnosis than in strangulated hernia. In typical cases, fortunately, the diagnosis is attended with little difficulty. In a hernia previously irreducible, the condition of obstruction or inflammation of the hernial contents may cause one to suspect strangulation. In obstructed hernia, however, the impulse is usually present, pain is less acute, and the other symptoms are much less marked than in the case of true strangulation. The same is true of inflamed hernia. Strangulation sometimes occurs synchronously with the development of a hernia; I have observed two such cases. Given a patient with the symptoms of intestinal obstruction, careful examination should be made of all the sites at which a hernia might occur.

Hernial strangulation under one year is more common than later, and the greatest frequency is in the first three months of life. The cardinal symptoms peculiar to infants are violent and uncontrollable screaming, recurrent vomiting (often fecal),

drawn facies, and tendency to both retention of urine and rapid collapse. In the diagnosis one must exclude acute hydrocele and acutely inflamed ectopic testicle. After prompt operation the mortality should be 10 per cent. or less. Taxis is dangerous and usually fails. A. N. Collins (*Annals of Surg.*, Feb., 1913).

**Hydrocele of the Cord.**—In the young there is a condition to which attention seldom has been called, and that not infrequently in the hands of the general practitioner causes a mistaken diagnosis of strangulation. This condition is hydrocele of the cord. In this disorder the swelling is more tense and cystic to the touch; it is more freely movable, more globular in outline, and has a more sharply defined upper border, which, upon careful examination, shows that it does not enter the abdominal cavity. In a very few cases it may be difficult to differentiate between the two conditions from physical signs alone, but invariably the clinical history of the swelling will render the diagnosis easy. If there is hydrocele of the cord, there will be absolutely no general symptoms, and, if the statements of the parents be of any value, it will be found that the swelling has existed for several days or weeks, which shows the impossibility of its being a hernia.

Volvulus may produce in a hernia signs and symptoms accurately simulating hernial strangulation; or it may be associated with actual strangulated hernia. Miller (*Annals of Surg.*, Feb., 1911).

In a total of 550 hernia cases the writer saw 107 strangulated herniæ, 60 inguinal, and 47 femoral. In 45 per cent. the hernia was reduced and a radical curative operation performed. In 55 per cent. immediate operation for emptying the sac was necessary. In only 6 per cent. was

resection required to empty the sac, and in only 3 per cent. was the vitality of the loop doubtful. There was no relation between the gravity of the anatomical lesions in the herniated viscera and the time at which incarceration occurred. The viscera seemed to tolerate strangulation well, especially in old persons. G. Bolognesi (*Arch. de méd. expér. et d'anat. path.*, xxviii, 403, 1919).

[At the Hospital for Ruptured and Crippled, among 28 cases operated upon for strangulated hernia in children under the age of 2 years, not a single death occurred. The youngest patient was aged 13 days and the strangulated hernia had existed fourteen hours. A **Bassini operation** was done and a permanent cure effected. WILLIAM B. COLEY.]

**TREATMENT OF STRANGULATED HERNIA.**—**Taxis.**—Taxis and operation comprise the only methods of treatment to be considered. Taxis judiciously applied should always be used before operation is advised. Various positions of the patient are supposed to be of advantage in performing taxis. In inguinal hernia the pelvis should be elevated and the thighs flexed; in femoral hernia the thighs should be flexed and slightly rotated inward; in umbilical hernia both thighs should be flexed in order to relax the abdominal muscles. Traction on the tumor, followed by pressure, will often aid in reduction.

[Some, notably Hern, advocate withdrawing the fluid from the hernial sac by means of a fine hypodermic syringe prior to taxis. Out of 33 cases thus treated reduction was accomplished in 29. He advises this method only in cases of recent strangulation and which refuse operation. It certainly should not be advocated as a routine treatment. WILLIAM B. COLEY].

Violent or prolonged taxis is attended with great risk; the bowel may be lacerated or so severely con-



tused that gangrene ensues. Often the sac has been ruptured by too forcible taxis. Methods of taxis which were perfectly justifiable when the mortality from operative treatment was very high, are no longer to be tolerated.

The following statistics as to acute reduction *en masse* have been recorded by Corner and Hewitt: Males, 110 cases, or 86 per cent.; females, 18, or 14 per cent. Inguinal, 113, or 83 per cent.; femoral, 22, or 16 per cent.; obturator, 2, or 1 per cent.; umbilical, 0. Inguinal, died, 54, or 48 per cent.; femoral, 16, or 72 per cent.; obturator, 2, or 100 per cent.

Method of reduction *en masse*. By medical man, 50 per cent.; by patient, 28 per cent.; uncertain, 18 per cent.; spontaneously, 4 per cent.

While in acute cases of reduction *en masse* the viscus reduced is almost always small bowel, the less numerous subacute and chronic cases are found among the hernias containing omentum, large bowel, or bladder.

Reduction *en masse* is to be suspected if the signs and symptoms of obstruction persist after reduction of the hernia. The proper treatment of these cases is to operate, either by making an incision in the middle line of the abdomen below the umbilicus when the exact diagnosis is uncertain, or if the cause of the illness can be ascertained, over the region where the hernia was reduced *en masse*, especially if the inguinal canal feels "full."

The risks entailed by taxis are formulated by the writer thus: (1) Reduction of the hernia *en masse*, with persistence of the symptoms of strangulation; (2) rupture of the intestine; (3) contusion or laceration of the intestinal wall; (4) reduction of gangrenous intestine into the abdominal cavity; (5) forcing of infected sac contents into the peritoneal cavity; (6) ulceration and perforation of reduced intestine several hours or days after reduction; (7) intestinal hemorrhage from too forcible taxis; (8) incomplete reduction; (9) rupture of the sac near the neck and subperitoneal reduction

of the hernia; (10) tearing loose of the constriction of the neck of the sac and reduction of it along with the intestine into the abdominal cavity; (11) failure to relieve the strangulation when the constriction is intrasaccular; (12) torsion of the loop persisting after reduction; (13) intestinal paresis following forcible or repeated taxis; (14) separation of the mesentery; (15) acute intestinal volvulus; (16) intussusception; (17) omental torsion and intestinal stenosis as a late complication. L. F. Watson (Internat. Clin., June, 1924).

**Taxis** should be used only in rare cases. It may seem justifiable under 2 conditions: (1) In so-called "fecal incarceration," generally affecting large hernias with a wide ring, and often in old persons with repeated incarceration; (2) when not over 1 hour has passed since the beginning of the incarceration. Old age and diseases of senility are indications for taxis only under these conditions. Taxis is absolutely contraindicated: (1) In so-called "elastic incarceration," involving a small hernia, with abrupt severe symptoms; (2) when over 1 hour has elapsed; (3) if there are already evidences of inflammation, such as redness or swelling of the skin and marked sensitiveness. Preparation for taxis consists in injection of 0.01 to 0.02 Gm. ( $\frac{1}{4}$  to  $\frac{1}{2}$  grain) of **morphine** and institution of the **Trendelenburg position** with the hips flexed. If vomiting has occurred, the **stomach** should be **washed out**. If the urine is retained the **bladder** should be **evacuated**. General anesthesia should not be used. Under **local anesthesia** a small incarcerated hernia will sometimes slide back spontaneously. All should be in readiness for an operation. In attempting the reposition, one should endeavor carefully to push back the parts lying next to the hernial ring; sounds will soon be heard if this is possible. If the attempt fails after 15 minutes, a **hot bath** may be administered. If reduction is effected a **truss** should be applied immediately. A. Krecke (Münch. med. Woch., Aug. 1, 1924).

In cases that have been irreducible prior to strangulation—as is generally the case in strangulated umbilical hernia—taxis is clearly contraindicated. Likewise in cases where strangulation has lasted for twenty-four hours or longer, no attempt should be made to reduce the hernia.

Following contraindications to taxis referred to: (1) taxis already thoroughly tried; (2) case extremely acute and violent; (3) when several days have intervened; (4) irreducible hernia; (5) stercoraceous vomiting; (6) suspicion of inflammation or gangrene; (7) where a skillful and clean operation can be immediately performed. Hilton (Jour. Amer. Med. Assoc., May 18, 1907).

Taxis should seldom be employed longer than from three to five minutes, and moderate force only should be used. The application of an **ice-bag** (hot cloths are preferable in children and old people) may facilitate reduction. In infants and young children it is a good rule, after an unsuccessful attempt to reduce the hernia by taxis, to prepare immediately for operation, and then, if reduction under an anesthetic be not successful, operation may be at once performed without subjecting the patient to a second anesthetization.

Subcutaneous injections of 0.002 Gm. ( $\frac{1}{2}$  grain) of **atropine sulphate** useful in cases of strangulated hernia. The patient is placed on a hard table, an ice compress applied over the hernia, and half an hour after the injection an attempt made to reduce by gentle taxis. It is often well to place the patient in the genupectoral position, and to give a second injection if there is further difficulty, but the attempts at reduction should be very gentle. The method is indicated as a preliminary to operation in cases seen very early, and also where operative interference is refused, or contra-

indicated. Tcherkesson (Hospital, April 18, 1908).

Report of 4 cases of hernia irreducible by taxis in which spontaneous reduction took place after subcutaneous injection of **atropine**. Rabl (Münch. med. Woch., Oct. 27, 1908).

Before **taxis** the patient must be anesthetized. The loop should be reduced spontaneously by traction from its mesentery, never by applying force directly to the hernia. Pain should be abolished by a preliminary injection of 0.01 Gm. ( $\frac{1}{4}$  grain) **morphine**. The patient should draw up the legs, and a small pillow be placed under the shoulders to relax the abdominal muscles. **Ice or compresses wrung out from ice-water or ether** should be applied to the hernia, and the buttocks raised, the head and shoulders being lowered. The mass of intestines slides down on the diaphragm and the mesentery, through gravity, pulls on the strangulated loop. If reduction is possible these measures will accomplish it in two hours at most. If they fail, direct force would not have done more. Hardouin (Presse méd., Nov. 20, 1909).

**Scopolamine hydrobromide** used in strangulated hernia to paralyze motor ganglia of intestines. Gases in strangulated portion pass beyond seat of constriction, and reduction is facilitated or occurs spontaneously. Dose not to exceed  $\frac{1}{2}$  or  $\frac{1}{4}$  grain (0.005 to 0.01 Gm.). Method contraindicated in children. Luxardo (Gaz. degli Osp., June 9, 1910).

Case seen by the writer after 8 hours of strangulation and in bad general condition. The amount of prolapsed bowel was equal in volume to the fetal head, and the circumference of the pedicle was not over 16 c.c.. The writer placed the patient at rest and gave him 1 Gm. (15 grains) of **citrate of caffeine** in small, frequent doses. Under this management the hernia underwent a slow, spontaneous reduction. The caffeine had a special action on unstriated muscle. The writer recommends the

caffeine treatment as rapid and painless. Bernardo Gil y Ortega (*El Siglo Medico*, Jan. 20, 1917).

In irreducible inguinal and femoral hernia the writer reduces the intestinal loops as far as the neck of the sac by pressure with a finger introduced into the vagina or rectum. A sort of aspiration of the gas contained in the gut is thus produced. J. Neumann (*Wiener med. Woch.*, Aug. 17, 1918).

**OPERATION FOR STRANGULATED HERNIA.**—**Incision.**—Instead of the old incision over the most prominent part of the tumor, usually the upper scrotum, it is much better to make the ordinary Bassini incision, parallel to Poupart's ligament, extending only slightly beyond the external ring. This incision is carried down to the aponeurosis of the external oblique, which is slit up about two inches.

**Sac.**—The sac is next exposed by careful dissection and opened by a scalpel or scissors. On opening the sac a smaller or larger quantity of fluid almost always escapes. The character of this fluid should be carefully noted, inasmuch as this gives an important indication as to the condition of the bowel. If the bowel is simply congested, the fluid will be clear; if inflammatory changes have taken place, it will be turbid, but free from odor; if the intestine is gangrenous the fluid is seropurulent and almost always has an intestinal odor.

**Division of Constriction.**—Before attempting to reduce the bowel the constriction must be divided. This may be either the neck of the sac or the fibrous structures forming the external ring, which have already been slit up.

By performing the operation as indicated, the constriction caused by

the external ring disappears with the slitting up of the aponeurosis of the external oblique.

[If the real cause of the constriction were the neck of the sac, it would still be impossible to reduce the hernia. In every one of 7 cases of mine (in children) the aponeurosis was widely opened, and this alone was sufficient to render reduction of the hernia easy, which would have been impossible had the constriction been due to the neck of the sac. This view, as I have stated, is directly contrary to the teachings of most writers. Taniel states that, out of 81 cases of strangulated hernia in children which he collected, the neck of the sac was regarded as the cause of the constriction in 58 cases. WILLIAM B. COLEY.]

**Management of the Contents.**—The bowel should be treated with the utmost gentleness, and a warm towel should be frequently applied until it is reduced. If the serous coat is still smooth and glistening, it may be safely reduced. A purple or mahogany color—provided the gut has not lost its elasticity—is not a contraindication for replacing it in the abdominal cavity. In case of doubt as to the propriety of returning the bowel, it is well to apply a hot towel for a few minutes, the constriction having been relieved. If the circulation materially improves, it can be returned with safety.

If the peritoneal coat is granular and devoid of luster and remains cold after the division of the constriction, it would be the better plan not to return the intestine, but to allow it to remain in place, protecting it by a sterile dressing. Examination a few hours later will determine whether it has sufficient vitality to permit of its being returned with safety into the abdominal cavity.

In operations for strangulated hernia in which the vitality of the bowel

is in doubt, the author places a layer of **iodoform gauze** three inches in width, against one side of the mesentery, contiguous to the bowel of doubtful vitality, passing it over the bowel, and then down the opposite side of the mesentery. The loop of bowel thus covered is placed just under the abdominal wound. One or two of the ligatures of the wound are left untied, and the end of the gauze, for the length of a foot or more, is allowed to hang out of the wound. The gauze quickly adheres to the peritoneum, adhesive exudate is thrown out in abundance, and if perforation occurs the discharge does not contaminate the peritoneal cavity. After a few days the gauze may be removed without force and a rubber drainage-tube substituted. The resulting fistula usually heals spontaneously. Hall (*Amer. Jour. of Obstet.*, Feb., 1907).

**Resection** of the intestine in incarcerated hernia is especially necessary when the groove in the bowel remains after reduction, showing that the mucosa has probably been injured beyond repair, and will lose its vitality either directly or secondarily, so that there is liability to subsequent stenosis. Stricture can develop from the mucosa and submucosa alone, the other intestinal layers being still intact. H. Matti (*Deut. Zeit. f. Chir.*, June, 1911).

If the bowel is gangrenous, and there is no doubt that it is unsafe to return it, two methods of procedure may be adopted: **Primary resection** may be performed, or the **gangrenous knuckle may be left in place**. If left in place, there is no need of sutures, as the adhesions will be sufficient to prevent it from slipping back into the abdomen. The gut may be simply opened and the wound fully protected with antiseptic dressing, the gangrenous knuckle may be removed, and the cut ends of the gut fastened to the skin by means of sutures.

Where the viability of the gut is in doubt, the author draws it out through an incision at the lower external border of the rectus muscle and wraps it in a towel or gauze wrung out of hot normal salt solution, to be repeatedly changed. If after the operation for hernia is over the gut has completely recovered, it may be returned; while, if resection is demanded, it may be done more easily and thoroughly through the second opening, without interfering with the recovery of the original hernial site. When, at the beginning, the gut is absolutely gangrenous, it is drawn out and tied off with strong silk, the dead portion cut away, the ends of the gut cauterized with phenol and alcohol, hemorrhage controlled, the parts thoroughly cleansed, and after a change of gloves, an incision made at the border of the rectus. The long ends of the silk are caught in forceps inserted through the second incision and the gut drawn out through the latter, after which the author proceeds to do a radical operation for hernia and, finally, to unite the gut. D. Macrae (*Iowa Med. Jour.*, Sept., 1909).

In the choice of procedures much must be left to the judgment of the operator himself. If he is a surgeon possessing the requisite technical skill, and the patient's condition does not contraindicate a prolonged operation, it is probable that primary resection will give the better result. This is especially true if the amount of intestine is small.

Eighteen cases of **resection and anastomosis** done in gangrenous strangulated hernia, with 8 recoveries—a recovery rate of 45 per cent. Cases of **anastomosis by circular enterorrhaphy** did better than those by lateral anastomosis.

Of 10 cases in which the resection was followed by the making of an artificial anus, there was only 1 recovery; 2 cases were treated by **invagination of the gangrenous or**

**doubtful area.** Both recovered, but the method is applicable only to small areas of necrotic or doubtful bowel. The mortality in complicated strangulated inguinal hernias was 37 per cent.; complicated strangulated femoral hernias, 66 per cent.; complicated strangulated umbilical and ventral hernias, 80 per cent. Among 216 strangulated inguinal hernias, gangrene was recognized in 8, or 3.6 per cent.; among 133 strangulated femoral hernias, in 12, or 9 per cent., and among 46 strangulated umbilical and ventral hernias, in 10, or 21.7 per cent. Corner (*Lancet*, June 13, 1908).

Case operated upon for a strangulated femoral hernia in which the mesentery of the herniated loop of intestine was found to be disinserted for an extent of about 45 cm. **Resection** of the intestinal loop for about 50 cm. and an **end-to-end anastomosis** was done, an uneventful recovery following. Only 9 other cases of mesenteric disinsertion in connection with strangulated hernia were found in the literature. There is no special symptomatology. A. Gallo (*Semana Méd.*, xxv, 553, 1918).

In hernia of the intestinal wall—Richter's hernia—permeability of the intestine, which sometimes exists, does not contraindicate operation. The condition is most frequently found in the femoral canal. The narrow incarcerating ring presses strongly on the intestinal wall and causes disturbance of tissue nutrition. Not infrequently gangrene of the bowel wall follows, even in the first few days. Slitting of the hernial sac must be done at the point where there are the fewest adhesions with the intestinal serosa, *viz.*, in the middle, between the apex of the cone and the strangulation groove. Dilatation of the ring should be preceded by fixation of the incarcerated cone with an elastic intestinal clamp. A **side-to-side anastomosis** is considerably easier to perform than a circular resection; the blind ends become obliterated in the course of time. A. Kosyrew (*Arch. f. klin. Chir.*, Sept., 22, 1923).

In spite of the fact that the chances of strangulation are very much greater in femoral than in inguinal hernia, the consent of the patient to operation before strangulation occurs is more difficult to obtain. More attention should be given, in cases of strangulated femoral hernia that are operated on early, to the possible presence of lines of necrosis in the intestinal wall due to the pressure of the sharp edge of Gimbernat's ligament. The invagination of such areas by Lembert suture will often give adequate protection against later perforation in such necrotic areas. T. Turner Thomas (*Atlantic Med. Jour.*, Oct., 1924).

In patients suffering from prolonged strangulation and who are much prostrated, or when the amount of intestine is very large, it is much safer to leave the gut in place to be dealt with at a subsequent operation. If the operator has had little experience in intestinal surgery, there is no room for debate as to which is the safer procedure. In many cases of femoral hernia the **artificial anus** has been known to close spontaneously.

Of 272 persons operated on by the writer for inguinal or femoral hernia in a 5-year period, 30 had strangulated hernias. There was 1 death, a mortality of 3.3 per cent. There were 18 males and 12 females. Of the 245 inguinal hernias, 6.9 were strangulated, as against 48.2 per cent. of the 27 femoral hernias. **Operation** should be strongly advised in all cases of femoral hernia unless there is a special contraindication, and the patient should be warned to notify his physician of any unusual trouble.

Administering a general anesthetic in young, healthy individuals does not lessen the chance of recovery when the case is seen early and there is no regurgitant vomiting, distention or other contraindication. All of his very sick cases and most of the old persons were operated under local anesthesia. It is important to relieve the constrict-

tion sufficiently to allow the bowel to be safely replaced within the abdomen without undue traumatism, or to be withdrawn for inspection and hot applications if necessary. After all the tissues of the neck of the sac have been cut down to the peritoneum, the sac itself should be gently stretched. M. T. Field (Boston Med. and Surg. Jour., Apr. 24, 1924).

Case of strangulated obturator hernia in a woman of 64 in which there was no local pain nor tenderness on abdominal and vaginal palpation. She was seized with colic and vomiting, finally fecaloid, indicating obstruction high up in the small intestine. Upon laparotomy the condition of the strangulated loop called for a **resection** with **end-to-end anastomosis**, recovery following. Gruget (Rev. de chir., xliii, 140, 1924).

**Intestinal Resection in Strangulated Hernia.** There has been a growing tendency in favor of **immediate resection** under favorable conditions. The question has been fully discussed by Delore and Thévenot, of Lyons, France, whose views are based upon a very extensive operative experience covering 166 personal cases of strangulated inguinal and femoral hernia.

The results, in their series of cases of strangulation, support their position: Of 101 strangulated crural hernias, 85 were cured, 16 died; of 65 inguinal hernias, 53 were cured, 12 died. Thus, in a total of 166 cases of strangulated inguinal and crural hernia, there were 28 deaths, or a general mortality of 16.8 per cent. Of these 166 hernias, 137 were operated upon without resection, 29 with resection; and, strange to say, the mortality of the 137 cases operated upon without resection was 24, or 17.5 per cent., while in the 29 cases treated by resection, there were only

4 deaths, or a mortality of 13.8 per cent.

That the writers did not abuse intestinal resection, by practising it in cases in which there was no indication in order to obtain very favorable results, is shown by the fact that resection was done in only 29 of the 166 cases.

That in strangulated hernias treated by simple reduction the mortality



Femoral hernia in a child aged 7 years.

was 17.5 per cent., while in the cases treated by resection it was but 13.8 per cent., in an observation that requires some explanation.

These successes are attributed by the authors to the following:—

1. Most rigid operative technique.
2. The application, if possible, of the principle, always to operate upon sound tissue. They believe that many of the failures, in previous intestinal resections in strangulated hernia, have been due to the fact that

surgeons generally make such resections too limited.

3. The fact that in cases of doubt they think it better to resect the suspicious intestinal coil, since it is always difficult accurately to estimate its vitality, as was shown in 6 of their own cases in which they practised simple reduction of the coil which had every appearance of being intact, but in which death followed in every instance as a result of intestinal gangrene and peritonitis.

4. Resection of the intestinal coil prevents the later occurrence of intestinal stenosis, adhesions, strangulation by bands, etc., which are by no means infrequent when a doubtful loop is replaced.

I must say that I am in thorough accord with the position taken by Delore and Thévenot, and my own experience is in harmony with theirs. Within the last year I have seen a death in the hands of one of my colleagues from replacing a doubtful loop of intestine in a case of strangulated hernia. The patient lived between two and three weeks, and then died of intestinal paresis and infection.

#### INDICATIONS AND CONTRA-INDICATIONS FOR THE RADICAL OPERATION.—Children.—

The indications for operation may be classed as follows:—1. Cases of adherent omentum. 2. Cases complicated with reducible hydrocele. 3. Cases irreducible and strangulated. 4. Cases unable to obtain the care and attention requisite for successful mechanical treatment. 5. Cases over 4 years of age, where mechanical treatment has been faithfully tried for a number of years without benefit. 6. Femoral hernia in children, which, though rare, cannot be cured by trusses. I believe

it is seldom necessary to operate upon children under 4 years of age, and the practice of some surgeons of operating upon infants under 1 year is open to serious question.

Umbilical hernia in children should, with very rare exceptions, never be operated upon, for the reason that it is almost invariably cured either spontaneously or by means of mechanical support.

Over 90 per cent. of all hernias encountered by the writer in children less than 12 years of age healed spontaneously or under a non-surgical treatment. The latter consisted of a diet calculated to prevent abnormal intra-abdominal pressure, overcoming factors such as constipation, phimosis, crying, and cough, and in keeping the child in bed with the foot of the bed elevated for at least 14 hours each day. There are, however, certain classes of hernia in children which should be operated on, 1, reducible strangulated hernia; 2, hernia complicated with hydrocele of the cord located in the inguinal canal; 3, hernia with omentum or intestine adherent to the sac; 4, hernia with congenital weakness of the tissues which normally should close the inguinal canal; 5, hernia with a tendency to strangulation but without a tendency to spontaneous healing; 6, hernia with cryptorchism without tendency to spontaneous cure. All these cases, constituting only about 5 per cent. of all hernias, require careful removal of the hernial sac and closure of the external wound. Classes 1, 3, and 5, are especially suited for the Anderson method. In Class 2, the hydrocele should be opened and everted. In Class 4 the Ferguson-Andrews-Bloodgood operation is indicated, and in Class 6 the Ferguson-Andrews-Bevan procedure. A. J. Ochsner (St. Paul Med. Jour., May, 1917).

**Adults.**—1. In a general way, the younger the patient the better the chances of radical cure.

2. Operation is indicated in all young adults, inasmuch as there is little prospect of cure by a truss after the age of maturity. The operation in skilled hands is attended with almost no risk and the chances of a cure without the further need of a truss are excellent (98 per cent.—Mayo).

3. All cases of irreducible omentum in patients that are fit subjects for an abdominal operation.

4. All cases of femoral hernia in which no contraindication is present.

**Contraindications.**—Very large irreducible hernia in stout persons should not, as a rule, be operated upon. The risks are large and there is little prospect of permanent cure.

### INGUINAL HERNIA.

**Radical Operation.**—The weight of evidence is strongly in favor of the superiority of **Bassini's method** in operating for inguinal hernia. This method, first performed by its author in 1884, was introduced to the profession in 1890. Bassini published 251 cases with 1 death and 7 relapses. It is performed in the following manner: The canal being laid open to the internal ring, the sac is separated, drawn down, ligated, and resected. The closed peritoneum is then returned, the spermatic cord is pushed aside, and the posterior margin of Poupart's ligament is exposed. The border of the rectus and the edges of the internal oblique, the transversalis, and the transversalis fascia are next sutured to Poupart's ligament under the cord. The latter is then placed upon the layer of abdominal wall thus formed, and the border of the external is sutured to Poupart's ligament over the cord, avoiding com-

pression of the latter. A new canal is now formed for the cord. The wound is then closed.

A modified Bassini technique intended to lessen recurrence, and which proved especially valuable in recurrent oblique inguinal hernias, is described by the writer: After the usual initial steps of the Bassini, the cord is reduced in size by removal of its coverings, leaving only the vas and vessels. The upper flap of the aponeurosis, having been liberated from the internal oblique to the outer border of the rectus, the cord is placed on the former



Double inguinal hernia (inoperable).

muscle  $\frac{1}{2}$  to 1 inch within the deep suture line and fixed by 1 or 2 mattress sutures, introduced outside the cord, internally to the deep suture line, and uniting the inner surface of the aponeurosis to the internal oblique and conjoined tendon. Overlapping of the aponeurotic flaps is done as usual. The aponeurosis is often sutured to the deep suture line (Poupart's ligament, internal oblique and conjoined tendon) as high as the lower edge of the internal ring, thus reinforcing the latter. In this procedure there is no risk of getting the sutures tight enough to press on the cord, in spite of the increased length of the canal. The operation is not feasible where the cord is abnormally short, nor in recurrent hernias when the aponeurosis of the



external oblique is deficient or replaced by scar tissue. When the internal oblique is poorly developed, the mattress sutures join the aponeurosis to the cremaster and transversalis. L. F. Watson (*Surg., Gyn. and Obst.*, Jan., 1925).

*Andrews's Operation.*—This is characterized by imbrication of the layers of the abdominal wall. In a similar technique employed by F. T. Stewart, after the internal ring has been made snug by passing sutures through the transversalis fascia, the canal is closed above the cord by suturing the transversalis and internal and external obliques as one layer to Poupart's ligament, the external oblique fascia thus reinforcing the subjacent muscle tissues. The needle is passed through these structures from without inwards, then through the ligament from within outward, a finger meanwhile protecting the femoral vessels. For precise coaptation and greater strength, deep and superficial sutures are alternately introduced. The lower flap of the external oblique is then carried up over the upper flap, sutured to it, and the skin incision closed.

*Ferguson's Operation.*—This procedure is planned to prevent recurrence due to deficient natural attachment of the internal oblique and transversalis muscles to Poupart's ligament. The incision is semilunar, with convexity upward, beginning over Poupart's ligament,  $1\frac{1}{2}$  inches below the anterior superior spine, and ending near the pubis, over the conjoined tendon. The external abdominal ring is then incised to the intercolumnar fascia, and the longitudinal fibers of the external oblique separated over the inguinal canal to beyond the internal ring. The hernial sac having been separated from the cord and internal ring, it is opened, tied high up and cut off, and its stump dropped into the abdominal cavity. The spermatic cord is left untouched unless there is varicocele. Removal of any excess of subserous fat is recommended. In bringing back the various structures to their normal situations, care is

taken to tighten down the stretched transversalis fascia over the cord by means of a continuous or interrupted suture, thus reducing internal ring to small size. The lower margins of the internal oblique and transversalis muscles are then freshened, Poupart's ligament scarified, and the muscles sutured to the ligament two-thirds of the way down the latter. Finally, the external oblique aponeurosis is sutured, restoring the external ring, and the skin incision closed.

*Halsted's Operation.*—In the newer technique of this operation, incision of the skin and external oblique aponeurosis is first effected as in the Bassini operation. The cremaster muscle and fascia are then incised and the internal oblique muscle exposed. Large veins, if found, are removed after ligation well up in the abdomen, and well above the testicle, but the vas deferens is allowed to remain in its bed. After ligation or purse-string suturing of the hernial sac the latter is pulled outward beneath the internal oblique with a long curved needle attached to the ligating sutures, and the ends of these sutures tied together over a narrow portion of the muscle. The lower flap, consisting of cremaster muscle and fascia, is then carried beneath the internal oblique and sutured, the internal oblique and conjoined tendon next sutured to Poupart's ligament, with the margin of the former tucked under the ligament, the external oblique then closed with sutures, and the incision in the skin finally closed. EDITORS.]

**Halsted's method**, while it closely resembles that of Bassini, differs in the direction of more complicated technique. The published results, though excellent, are inferior to those of Bassini.

The various operations for inguinal hernia as now performed are all more or less based upon the primary Bassini or Halsted technique. In this country the MacEwen and Kocher operations are no longer in vogue. Whether the

cord is transplanted or whether it is left in place without overlapping of the external oblique fascia, or with imbrication of the aponeurosis, the essential underlying principle is the removal of the sac and the closure of the hernial opening by suturing the internal oblique muscle and conjoined tendon to Poupart's ligament. No one operation will fit all cases, but the technique need not vary greatly to be generally useful. The writer has found the Andrews imbrication operation the one best fulfilling all possible indications. The cord should, however, always be transplanted. In direct hernias the cord is allowed to emerge directly through the aponeurosis as in the Halsted operation. In indirect hernias the cord lies between the 2 layers of imbricated external oblique fascia. Hessler (Surg., Gyn. and Obst., Oct., 1922).

In a report of 2468 operations by Coley for hernia, the author refers to 824 for inguinal hernia in patients under 15 years of both sexes, thus illustrating the wisdom of resorting to curative measures in children, instead of depending upon the truss. The latter is used only in children under 3. The 824 operated cases did not suffer a single recurrence, nor any mortality. In the 963 operations in males over 15 years, the Bassini operation with transplantation of the cord was resorted to in the great majority of cases. Hoguet (Surg., Gyn. and Obst., July, 1923).

The internal oblique muscle and Poupart's ligament were found to unite firmly in the dog when brought into apposition by suture—this in spite of considerable tension on the sutures. The cutting away of a small strip of the edge of the internal oblique, thus making a raw surface, tends to make the union firmer than usual. The experiments show that muscle unites with fascia by the union of the fascia with the fibrous components of the muscle. Both muscle and fascia should be stripped of alveolar tissue before they are sutured together. Still better

results are obtained if raw surface of muscle is sutured to fascia. A. R. Koontz (Surg., Gyn. and Obst., Feb., 1926).

A method has been employed in a large number of cases by Bull and Coley which they have named "suture of the canal without transplantation of the cord," the other steps being identical with Bassini's operation. The results have been nearly, if not quite, as good as in Bassini's. The only advantage of the method lies in the direction of greater simplicity in technique.

After the sac has been tied off well beyond the neck at a point where it has begun to widen out into the general peritoneal cavity, the deep layer of sutures is placed as follows: With a small tape the cord is held up, and the first suture is placed so that it just touches the lower border of the cord, when the latter is brought vertically to the plane of the abdomen; three to four more through the internal oblique and Poupart's ligament will suffice to close the canal to the symphysis pubis. Next the suture above the cord is inserted. The incision in the aponeurosis is then closed from above downward by a small continuous suture of kangaroo tendon, and the skin with catgut. No drainage is used, and the wound is dressed very carefully with sterile dry gauze and cotton, and a spica bandage. A plaster spica is used in children under 10 years of age. The wound is dressed on the seventh day, and the patients are kept in bed two weeks, and allowed to go out in two and a half to three weeks, wearing a muslin spica bandage until four weeks have elapsed, after which time no support is worn.

All methods in which the sac is allowed to remain behind, to be disposed of in various ways, should be abandoned. If the sac is left behind there is less chance of securing primary union, and it affords no additional security against relapse.

In 30 cases, mostly of recurring direct or indirect inguinal hernia, the weak abdominal wall was repaired with **living sutures of fascia lata** about 7 inches long and  $\frac{1}{4}$  inch wide, threaded upon a curved large-eyed needle and woven into the edges of the surrounding muscles and aponeurosis much as one darns a sock or weaves a basket. The results in these difficult cases were extremely good, no recurrence having followed in any case for nearly 2 years. Gallie and Le Mesurier (*Can. Med. Assoc. Jour.*, July, 1921).

Stress laid on failure of the transversalis fascia to withstand the intra-abdominal pressure as a factor in hernia. The author endeavors to repair and strengthen it. The sac is amputated but no effort made to dissect it out, except in unusual cases. Dissection of the neck, however, which does not go as high as the deep epigastric artery is sufficient, and the repair of the hernia is begun by dividing the neck into an upper and lower half and by suturing the upper over the lower for at least 1 inch. The cremaster muscle is fastened under the internal oblique muscle to hold the tissues in place until union is firm. The external oblique muscle is repaired so as to restore the ring to normal. In *direct* inguinal hernias the same splitting and overlapping of the neck is performed; the transversalis fascia is sutured over it and a square of **fascia lata** from the thigh **transplanted** in front of it as a reinforcement. Two hundred and one hernias were thus repaired without any recurrence. P. W. Harrison (*Arch. of Surg.*, May, 1922).

The writer urges the advantage of using the **aponeurosis of the external**

**oblique** as a source of **living suture** in inguinal herniotomy, recalling the original method of Gallie and Le Mesurier which gave remarkable results. He presents a modification which renders unnecessary the creation of a new surgical wound to provide the sutures. His procedure is as follows: (1) All fat and subcutaneous tissues adhering to the external surface of the aponeurosis of the external oblique are carefully cleared away by scalpel and gauze dissection. This is done over an area 1 inch wide, extending from the external inguinal ring, upward and outward, for 5 to 6 inches. (2) The aponeurosis is split in the usual way, beginning at the external inguinal ring and continuing upward 5 or 6 inches, parallel with the fibers or "grain" of the aponeurosis. (3) The necessary number (usually about 2) of aponeurotic strips,  $\frac{1}{8}$  inch wide and 6 inches long, are cut for use as sutures. These strips are placed in moist gauze while the hernial sac is being ligated and excised. The strips are now threaded through large-eyed Hagedorn needles. (4) The conjoined tendon is sutured to Poupart's ligament by using these aponeurotic strips as sutures.

The technic of sewing with such unusual suture material necessitates that there be a strict carrying out of the details.

The major idea is to have good contact between Poupart's ligament, conjoined tendon and the strip of aponeurotic suture.

The hernial repair is made according to the operation which the surgeon prefers to use, such as the Bassini, the Ferguson, or the Andrews. F. E. Adair (*Jour. Amer. Med. Assoc.*, Feb. 23, 1924).

In a review of indications as to the best operation to choose in difficult hernias, the writers conclude that the **Bassini operation** with its modifications, such as transplanting the rectus muscle or sheath, gives a percentage of recurrences far too high in direct hernias and in oblique hernias in old persons. In such subjects it should

be abandoned. When the fascial structures at the hernial site are good, the procedure of **Andrews** or some **overlapping method** may give better results, but **McArthur's autoplactic sutures** laced across the posterior wall of the lower  $\frac{1}{2}$  of the inguinal canal seem best.

In bad direct hernias, old oblique hernias, all recurrent hernias and ventral hernias, **Gallie's procedure** gives the most promise.

The routine use of local anesthesia, by eliminating post-operative vomiting and retching, reduces the number of recurrences. **M. B. Tinker** and **H. B. Sutton** (*N. Y. State Jour. of Med.*, Aug., 1924).

As observed by the author, small, direct hernias may be associated with larger indirect hernias, the former being often overlooked at the operation. In a personal case there was, besides bilateral direct inguinal hernias, bilaterally a small indirect hernial sac, thus necessitating the removal of 4 hernial sacs. **K. Koch** (*Zent. f. Chir.*, Aug. 9, 1924).

All inguinal hernias in childhood are funicular in origin, and the acquired form is non-existent. In at least 10 per cent. of people 1 or both funicular processes are imperfectly obliterated, leaving conditions ready for the occurrence of hernia. Two per cent. of children develop hernia. A truss in a child merely converts an actual hernia into a potential one and the author prefers operation for removal of the sac. This applies also to oblique inguinal hernia in the male and to direct hernia.

The writer describes his procedure thus: Seize the sac in pressure forceps and pull it forcibly out. Strip the structures of the cord completely away from the sac and abdominal peritoneum; this involves working deeply in the abdomen. Free the neck of the sac by sweeping the finger all around it. Twist the sac tightly up until practically you can twist no more, pulling upon it all the time. This insures that the entire sac will be tor-

sioned up to where it comes off from the abdominal peritoneum, and it is at this point that the ligature must be applied. Do not transfix with a needle. Apply a crusher of some sort, and throw the ligature (always catgut) below it; the ligature will slip into the crushed part as the instrument is taken off. Then repair the incision in the external oblique. **R. Hamilton Russell** (*Surg., Gyn. and Obst.*, Nov., 1925).

As early as 1892, we employed in a limited number of cases a method identical with **Bassini's** without the step of transplanting the cord. Since this time 646 cases have been operated upon by this method at the Hospital for Ruptured and Crippled with 15 per cent. of relapses. In many cases of double hernia, the typical **Bassini** operation was done on one side, and the same operation without the transplantation of the cord, on the other, in order fairly to test the value of the two procedures. This method has been brought out under various names and has been advocated as a method superior to **Bassini's** method.

In our own experience there has been a larger percentage of recurrences in the cases in which the cord was not transplanted, than in those in which the typical **Bassini** method was employed. Out of 2122 hernia operations in which the cord was transplanted there were only 0.4 per cent. of relapses.

By a sliding hernia is meant one in which a fixed portion of bowel, the cecum or sigmoid, has descended through the hernial opening into a hernial pouch, in which case the descended portion of bowel is not entirely within the sac, only the anterior and lateral portions being covered by peritoneum. In operating it is noticed that the anterior and

lateral surfaces of the bowel are free, while the posterior portion is adherent. According to the author's procedure, large clamps grasping the sac are placed on either side near the fixed portion of bowel and parallel to its lumen. A second set of clamps is placed above these so that the sac may be cut between the first and second sets. These incisions should run up to or, preferably, beyond the ring, and by this procedure a flap of bowel is left on either side of the bowel. The bowel is then grasped and pulled upward as if to produce traction on the mesentery, and by careful dissection made free from the underlying structure. The bowel is loosened well beyond the ring, taking care not to injure the blood-vessels which lie in a sort of newly formed mesentery. The lateral flaps, having been turned back so as to cover over the denuded area, are sutured at their margin.

After the bowel has been made freely movable, it is returned to the abdominal cavity, and the next step consists in the partial reconstruction of the sac so that it may be sutured or ligated, as in uncomplicated hernia operations. If a triangular space of denuded bowel is thus formed just internal to the ring, it should be closed over by suturing the peritoneum; 15 cases were operated on by this method, of which 10 were sliding hernias of the sigmoid and 5 of the cecum. All were in adult males. In 8 cases there were double inguinal hernias, in 2 instances complicated by femoral hernias. All the cases recovered satisfactorily. W. C. G. Kirchner (*Jour. Mo. State Med. Assoc.*, June, 1912).

When operating upon inguinal hernias in children and young adults the author always looks for a sac on the other side. Of 18 cases, 10 showed such a sac, one-half to two or three inches long. Any sac found should be ligated, insuring the patient against the possibility of a second operation. E. W. Roughton (*Lancet*, June 8, 1912).

Few, if any, hernias, whether inguinal or ventral, can now be considered incurable. In **filigree implantation** is to be found the only true radical cure (for the severe cases). Of 263 inguinal hernias, 106 were treated by filigree implantation, and of 51 umbilical or ventral, 40. Some patients had undergone repeated operations ineffectually; 11 were over the age of 60. The use of filigree is attended by a slight increase in the danger of sepsis, but suppuration is not an indication for the removal of a filigree. Wires displaced into a sinus should be removed without disturbing the filigree. No belt or truss should ever be applied on the top of an implanted filigree. For the reduction of very large inguinal hernias and the avoidance of paralytic ileus the Trendelenburg position should be used, the abdomen opened, and the bowel withdrawn from within, aided by pressure from without.

In dealing with a gigantic hernia, spinal analgesia should be preferred to general anesthesia. Lawrie McGavin (*Proceed. Royal Soc. of Med.*, Jan., 1913).

The writer urges additional fortification of the inner half of the inguinal canal in cases of hernia in which the conjoined tendon and especially the internal oblique muscle is weak, attenuated, or deficient. His procedure consists of the suture of the inner half of the external oblique aponeurosis to Poupart's ligament after the internal oblique and conjoined tendon have been sutured and the overlapping of the internal half by the external half. After operation there should be moderate elevation of the trunk and thighs, which is easily obtained with the Gatch bed. W. S. Schley (*Annals of Surg.*, lxxi, 753, 1920).

**Results of Operation.**—Hernia can, for a considerable time at least, be cured by operation. Although no definite time-limit can be laid down beyond which relapse may not occur, a careful study of cases operated upon

enables us to arrive at certain fairly definite conclusions.

It may be stated in a general way that, if a rupture is sound at the end of one year after operation, there is a strong probability of permanent cure, while, if it remains well for two years, the chances of relapse are very small. Ninety-five per cent. is a conservative estimate of cures following Bassini's operation if the operation has been properly performed. This estimate presupposes a judicious selection of cases.

[Some operators openly state that they never select their cases. There is no field in surgery, I believe, in which there is greater need for the exercise of good judgment than in that of operations for the radical cure of hernia. WILLIAM B. COLEY.]

The practice of operating upon all cases of hernia, irrespective of the age of the patient and the size of the hernia, cannot be too strongly condemned.

The mortality attending hernia operations has changed very little since the earlier statistics. From December, 1890, to January, 1901, a period of 10 years, 2732 cases were operated upon at the Hospital for Ruptured and Crippled, with 6 deaths, or .22 per cent. From January, 1901, to January, 1918, 3358 were operated upon with 5 deaths, or .15 per cent. The later deaths referred for the most part to cases of large irreducible strangulated umbilical hernia.

With regard to the end results of the first period the authors report 15 recurrences in 2029 cases of inguinal hernia in the male, or .73 per cent., in the cases operated upon by the Bassini method, and 42.8 per cent. in the small group of cases operated upon by Czerny's method prior to 1891.

In the second period, from 1901 to 1918, covering 2200 cases, there were only 10 relapses or .45 per cent. In this series, as far as it has been possible to trace, 1667 cases have re-

mained well from 1 to 4 years; 586 cases have remained well from 5 to 9 years; 193 cases have remained well from 10 to 14 years; 46 cases have remained well from 15 to 19 years, and 14 cases have remained well from 20 to 26 years.

Of 216 cases of femoral hernia, 169 have occurred in adults and 47 in children under the age of 14 years. Ninety-nine cases have been traced in which the patients have remained well from 1 to 24 years after the operation, and in the entire series 8 recurrences are known to have taken place.

Of 166 cases of umbilical hernia, 118 occurred in adults and 48 in children; of the latter, 21 occurred in males and 27 in females. In 66 cases the patients are known to have been in good condition from 1 to 11 years after the operation, and in 25 cases for more than 3 years. Nine recurrences have taken place and 5 deaths; among the deaths was 1 case, a female 44 years of age in which an extensive operation for carcinoma of the ovary was performed in addition to the hernia operation, and the patient died 4 days later.

Of 103 cases of ventral hernia, 86 occurred in adults and 17 in children. In this series, 41 have remained well from 1 to 15 years, the remainder not having been traced, and 11 recurrences have taken place.

Of 15 cases of epigastric hernia, 12 occurred in children under the age of 14 years, and the remainder in adults. Six cases are known to have been well from 1 to 7 years after the operation, and in 2 cases a recurrence took place.

Among the local sequelæ following radical operations for hernia are: hydrocele and orchitis. Among the general sequelæ: bronchitis, pneumonia, phlebitis, intra-abdominal swelling due to inflammation of omental stump and embolism.

The writers believe that the local sequelæ are in direct proportion to the experience of the operator. If great care is exercised in dissecting the sac from the cord with a mini-

mum of trauma, the larger vessels tied before cutting and the small bleeding points controlled by ligature, hydrocele, orchitis, or local swelling will very rarely be observed. They always make a practice of supporting the testis by a little shelf or platform made of adhesive plaster placed across the upper portion of the thigh.

It has appeared somewhat remarkable that thus far there have been no deaths from embolism in the authors' series of 6500 operations performed at the Hospital for Ruptured and Crippled.

In 1383 adult cases of inguinal and femoral hernia cases operated upon at the Memorial Hospital by Coley and Downes, there were 2 deaths. In the first case, a male 35 years of age, operated upon by Coley, a large mass of omentum was replaced with some difficulty and probably considerable trauma. The patient died on the fifth day with gradually increasing distension and signs of peritonitis. The second case, operated upon by Downes, died of infection and peritonitis. In a third case of umbilical operated upon by Coley at the Memorial Hospital—a very large irreducible umbilical hernia in a stout woman—death occurred. It was found almost impossible to reduce the contents of the sac into the abdomen and when reduced respiration became difficult. The patient died 2 days later of heart failure; no evidence of sepsis. Another death occurred in a case operated upon at the Post-Graduate Hospital by Coley in 1895, in a strangulated femoral hernia with resection of the bowel. Hoguet's service shows 6 deaths; 2 males, 1 a strangulated indirect hernia with general peritonitis present at time of operation, and the other a simple indirect acute, with atrophy of the liver; and 4 females, 1 a strangulated femoral, no resection, shock; another, a strangulated femoral after gut resection; another, a direct inguinal, acute nephritis; and the fourth, a ventral, with pulmonary em-

bolism. W. B. Coley and J. P. Hoguet (*Annals of Surg.*, Sept., 1918).

Roux, of Lausanne, Switzerland (personal communication), has operated upon 1398 cases, with 5 deaths.

**Dangers and Complications of the Radical Operation.**—The chief dangers to be guarded against are pneumonia and wound infection. Prior to 1890, in the larger proportion of fatal cases, death was due to wound infection; but at present, with the gradual perfection of technique, I consider pneumonia from the anesthetic the greater source of danger. The mortality has been gradually reduced from about 6 per cent., in cases prior to 1890, to less than 1 per cent. in cases operated upon during the last decade. We have collected 8000 cases operated upon since 1890, showing a mortality of less than 1 per cent.

**Precautions.**—The greatest care should be exercised in cleansing the skin of the patient, as well as the hands of the surgeon and assistants.

We now use the iodine method of preparing the skin in the field of operation and rubber gloves for the operator.

Some form of absorbable material sufficiently durable to permit of tensinous union should be used for all the buried sutures. Kangaroo tendon, on account of its strength and pliability, may be regarded as superior to chromicized catgut. Catgut, if properly chromicized, may be nearly as good, but, as usually prepared, it is more harsh than the tendon and is more likely to cause irritation and subsequent production of a sinus, as is so frequently the case with non-absorbable suture material. My ob-

jections to non-absorbable sutures, including silk, silkworm gut, and silver wire (advocated by me in 1895) were based upon the observation of 16 cases in which the use of sutures was followed by the formation of sinuses and extrusion of the sutures. These sinuses often required many months to heal, and the prolonged suppuration so weakened the canal that in most cases relapse followed. This opinion has been further confirmed by more recent observations.

Suppuration after the Bassini operation can be due to oozing of blood in the deeper structures about the internal oblique and transversalis muscle or under the skin after the operation.

To obviate this, the utmost care should be exercised to stop oozing by compression and suture ligatures with very fine silk or catgut at the operation. When the wound is closed, a gauze roll is made an inch in diameter, and applied directly on the incision, covered by a pad two inches wide, which is secured in turn in two places by one-inch adhesive plaster. Over this is applied the regular wide section dressing of gauze and absorbent cotton, fastened in position by broad adhesive straps, snugly applied. The pressure produced by these straps is multiplied on the line of incision, tending to arrest further any capillary oozing, cause all secretions immediately to pass into the dressing, and obliterate all dead spaces. In addition the limb should be at once immobilized with a Liston splint. This is left in place as long as the patient is kept in bed. In 100 cases thus dealt with there was not a single breaking down of the wound by suppuration or other cause. Ernest Laplace (*Med. Bull.*, Jan., 1909).

Operative experience with recurrent herniæ showed that in indirect hernia the usual cause of recurrence is non-removal of the deeper part of the sac. An occasional cause is failure to find a small sac. Some recurrences

are due to a direct hernia, overlooked or developing subsequently. As to operation for its cure, in every case it must be determined whether the hernia is indirect or direct. The sac is most conveniently picked up at the internal ring. The external oblique aponeurosis is incised for 3 or 4 inches from the external ring and the flaps are turned back. The internal coverings of the cord are opened and the internal oblique is divided in the line of the canal for about 1 inch. If a sac is found the outermost part of the neck is reached without retraction. The sac is isolated by splitting the coverings and dissecting them free. It is then opened and, with a finger inside, is pushed forward against the peritoneum and transversalis fascia within the deep epigastric vessels. This shows the size of a direct hernia and the width between the conjoined tendon and Poupart's ligament. The external oblique is closed with the cord in its natural position. A. W. Sheen (*Lancet*, cc, p. 746, 1921).

Fine catgut is employed for the ligation of the arteries and for closing the skin. The catgut is prepared by boiling it in absolute alcohol at a temperature of 210° F. Both catgut and tendon that I have employed during the past 30 years have been prepared by Van Horn & Co., of New York. Bacteriological tests have invariably proved the material sterile.

**Regional anesthesia with procaine** is the method of choice in inguinal herniotomy. Usually this requires 100 c.c. (3½ ounces) of 0.5 per cent. and 50 c.c. (1½ ounces) of 1 per cent. procaine solution. To each 100 c.c. is added 10 minims (0.6 c.c.) of 1:1000 **adrenalin**. A skin wheal is made 2.5 cm. anterior to and above the anterior superior spine. Through it a long needle is inserted and moved about so that a plane of anesthesia perpendicular to the skin is produced by injections reaching down to the transversus fascia along a line reaching from the



anterior superior spine toward the umbilicus. This plane blocks the ilio-inguinal, iliohypogastric, and the last 2 thoracic nerves. Through another wheal produced just above the pubic spine deep injections are made for 3 to 4 cm. along the horizontal ramus of the pubis. A third wheal is made just below the inguinal ligament lateral to the femoral artery; through this deep injections are made under and along the ligament. The cord is injected through the pubic wheal and the internal ring also thus reached to block the genitofemoral nerve. Labat and Meeker (Surg., Gyn. and Obst., Mar., 1922).

To eliminate the "bladder bogy" in reconstruction of the parietal peritoneum at the point of herniation, the writer has the **bladder moderately distended with boric acid solution** before operation in direct hernia, and during operation in all cases in which the presence of the bladder in relation to the sac is suspected. This permits one boldly to suture the neck of the sac so that the resulting suture line shall be flush with the parietal peritoneum. A. Nicoll (Med. Rec., Jan. 21, 1922).

The **jack-knife position**, i.e., with the knees elevated by pillows and the trunk elevated at an angle of 25 to 45 degrees, is usually advisable following operation for inguinal, femoral, umbilical, or ventral hernia. It reduces the hernial opening by 25 to 50 per cent., facilitates the tying of the deep sutures, takes the strain off the stitches during the process of repair and reduces recurrences. It should be maintained for 5 to 10 days after operation. On the operating table, if not adjustable for the purpose, the elevation of the shoulders and knees is obtained with pillows or by placing the foot in a leg holder elevated to the proper position. L. F. Watson (Ann. of Surg., Aug., 1924).

**Complications.**—Orchitis, which occasionally was observed after the Bassini operation in the early days, is almost never seen if the operation is properly performed, with

little bruising of the tissues. In adult cases it is of great advantage, immediately after operation, to apply a strip of rubber plaster, about two inches wide, across the thighs in such a way as to form a support for the testes. It prevents any dragging on the cord and adds much to the comfort of the patients.

*Injury to the Cord.*—If the operation is performed with due care, there is no danger of injuring the cord, even in children. If the bleeding vessels are at once caught and tied, and the wound kept clean, the different layers of tissue can be recognized as easily as in a dissection on the cadaver. Bassini's operation cannot be properly performed unless this be done.

*Atrophy of the Testis.*—When Bassini's operation was first introduced, atrophy of the testis was regarded as a possible danger, and this deterred some surgeons from employing the method. Not a single case of atrophy of the testis has been observed in over 3000 Bassini operations at the Hospital for Ruptured and Crippled. I have seen, however atrophy of the testis follow secondary operation for recurrence in which many of the veins had to be sacrificed. Cases of atrophy have been occasionally observed after Halsted's operation, by Dr. Halsted himself, as well as by other surgeons. O'Connor reported 20 per cent. of atrophy of the testis in 129 cases operated upon by Halsted's method.

A study of 50 cases of pulmonary embolism after radical cure of inguinal hernia in the literature was made by Mauclore. Local infection was present in several cases, while some authors found the wound normal, but suspected the deeper parts. In Mauclore's own case the embolism resulted

from a phlebitis of the spermatic cord consequent upon manipulations during the operation. In 400 or 500 radical operations phlebitis was observed 4 or 5 times. The femoral vein may become involved in the course of the operation or at the later dressings. The phlebitis sometimes develops on the opposite side. Lesion of the epigastric vein may have been the original cause.

When a suspicious "cyst" is encountered during the operation, the possibility of its being the bladder can be excluded by injecting methylene blue solution into the bladder, distending it with air or water, passing a sound into it and palpating the tip in the wound, or aspirating the cyst with a fine hypodermic needle and testing the fluid for urine. In infants and young children the bladder is situated higher than in older children, and must not be mistaken for the hernial sac.

To prevent injury to the external iliac artery in passing deep sutures, the shelving edge of Poupart's ligament should be well exposed and care taken not to take too deep a bite in it. In recurrent hernia, the needle should be guided through the shelving edge of Poupart's ligament by the tip of the index finger, or the finger can be placed outside the ligament and the iliac vessels depressed as the needle is passed through the shelving edge. Needles and sutures should be at hand so that injury to these vessels can be repaired immediately. L. F. Watson (*Amer. Jour. of Surg.*, Apr., 1924).

Analyzing 264 cases of inguinal hernia operated by various surgeons during one year, the writer found that of 206 patients operated on 1 side only, 25 became septic; of 58 double operations, 8 became septic. There appears, then, to be no greater chance of post-operative wound infection in the double cases than in the single. Of the 206 patients on whom the single operation was performed, 8 had pulmonary complications; in the 58 subjected to a double operation, 12 had such compli-

cations. It is best, therefore, to refuse to operate on both sides at 1 sitting in a case of double hernia, not so much for fear of local sepsis as of pulmonary complications. J. C. Hubbard (*Boston Med. and Surg. Jour.*, Mar. 27, 1924).

Case of a man aged 25 who, after an operation for right inguinal hernia, noticed that his penis became smaller and smaller until, in the course of a few weeks, it was buried in the fat over the pubic region and could not be protruded beyond the glans. This reflex atrophy still existed 6 years later. G. Wilson (*Jour. Amer. Med. Assoc.*, May 24, 1924).

In all inguinal and femoral hernias in people past middle life the possibility of involvement of the bladder should be kept in mind. In any case a positive diagnosis of such a condition can be made by means of the X-ray. R. E. Farr and Brunkow (*Ann. of Surg.*, Aug., 1925).

### INGUINAL HERNIA IN THE FEMALE.

I have personally operated upon 353 cases of inguinal hernia in the female,—170 in adults and 183 in children,—and only 2 in this entire series were direct hernias. Both of these cases occurred in adults; one was operated upon some time ago for a double inguinal hernia with the bladder in the sac on the right side. This gives a proportion of 0.6 per cent., or, if we count the adults alone, as there are practically no direct hernias in children, it is 1.2 per cent. Comparing this with the cases of direct hernia in the male, I have operated upon 1776 cases of inguinal hernia in the male, of which 815 were in adults and 961 in children. Among these, I have observed 50 cases of direct inguinal hernia, or about 3 per cent. If we consider adults alone, which is the only correct way, we have 5.5 per cent. in the

male and 1.2 per cent. in the female, which would make direct hernia in the male occur five times more commonly than in the female.

Among the unusual cases of inguinal hernia in the female in our records are the following: Inguinal hernia of tube and ovary, 1 case, aged 12 years; 1 case, aged 6 years; 1 case, aged 3 years; 1 case, aged 48 years. Strangulated hernia of appendix with large amount of exudate, 1 case, aged 35 years. Double direct hernia with the bladder on the right side, 1 case, aged 55 years.

**Operative Treatment.**—The operative treatment of inguinal hernia in the female has received but little attention from most surgeons. Championnière was the first to urge it. His method was to excise the round ligament with the sac; but this I believe to be entirely unnecessary and not without objection.

The method of operation which I have employed was the same in the entire series of cases, and consists in an operation practically identical with the modified Bassini operation which the late Dr. Bull and I (*Annals of Surgery*, 1895, 1897, and 1898) introduced at the Hospital for Ruptured and Crippled in 1892.

The only variation from the typical Bassini operation is that the cord is not transplanted, but is allowed to emerge at the lower angle of the wound.

In the female, the round ligament is treated in the same way as the cord in the male, in that it is left undisturbed at the bottom of the wound, the internal oblique being sutured to Poupart's ligament; the aponeurosis is then closed, and last of all the skin sutures are inserted.

[In the *Annals of Surgery*, September, 1909, I discussed the subject of inguinal hernia in the female. I pointed out the fact that this type of hernia constitutes a fairly large percentage of inguinal hernias.

At the Hospital for Ruptured and Crippled, in the last twenty years, we have had 59,404 cases of inguinal hernia, of which 9082 were in the female. I made an analysis of 1692 cases with reference to the age of the patients at the time the hernia was first noticed. I found that in 66 of 1085 adult cases the hernia had existed in infancy or early childhood.

AGE OF PATIENTS AT TIME OF FIRST VISIT TO HOSPITAL.

Age.	Single.	Double.	Total.
Up to 1 year .....	140	24	164
1 to 5 years .....	171	21	192
5 to 10 years .....	150	32	182
10 to 14 years .....	56	4	60
14 to 21 years .....	83	11	94
21 to 31 years .....	164	30	194
31 to 41 years .....	254	57	311
41 to 51 years .....	177	54	231
Over 51 years .....	185	70	255
Age not stated ....	6	3	9
	1386	306	1692

WILLIAM B. COLEY.]

In the series of 353 cases referred to there was no death and but two relapses, and the large majority of the cases has been traced to their final result. One of the relapses occurred in a woman, of 35 years, two years after operation, and was brought on by very heavy lifting, which caused, at the same time, a hernia on the sound side. The second relapse was anticipated, for the reason that the operation had been performed in a woman aged 35 years, and seven months pregnant, with a very large strangulated inguinal hernia the size of two fists. The sac and outlying tissues, including fasciæ and muscles, were infiltrated with exudate, and the gut was in a precarious condition. The operation was performed as

rapidly as possible, and the wound closed with drainage. Extensive supuration followed, and, although the patient was delivered of a healthy child at full term, the wound had not become firm enough to stand the severe strain of childbirth, and relapse occurred shortly afterward.

### FEMORAL HERNIA.

In this variety of hernia the bowel protrudes through the femoral ring underneath Poupart's ligament. It penetrates the femoral or crural canal, the small space extending from the femoral ring to the saphenous opening of the fascia lata. On its inner side is Gimbernat's ligament; on the outer the femoral vein and its floor, as formed by the pubis, covered by the pectineus muscle. The peritoneal sac of a femoral hernia is always acquired. When it advances beyond the saphenous opening it usually becomes much larger. The hernia proper is formed by the skin, the superficial fascia, the cribiform fascia, the sheath of the vessels, the septum crurale, and the peritoncum. Its neck is at the femoral ring, where constriction occurs from the edge of Gimbernat's ligament. Although generally small, it occasionally attains large proportions. Besides intestine, the omentum is often found in it.

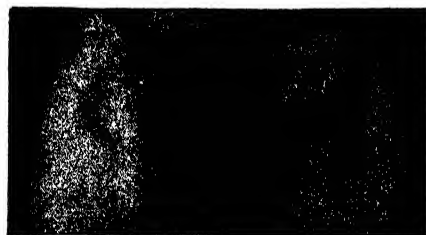
Femoral hernia seldom occurs before puberty, and is much more common in women than in men.

**DIAGNOSIS.**—When a femoral hernia is not strangulated, an impulse may be felt when the patient coughs. The tumor is generally tense, small, and round, and can be pushed to the outside of the spine of the pubis.

**Inguinal Hernia.**—From this variety the distinction is sometimes difficult,

especially in women; but the neck of a femoral hernia is always below the spine of the pubis and to the outer side.

A characteristic feature of femoral hernia, the small spherical swelling lying *below* the fold of the groin, remains when the hernia is reduced, and is due to a pad of fat arising from the extraperitoneal fat which normally occupies the crural canal. This fatty tumor is of diagnostic value, contrasting with the oblique elongated tumor above the ligament formed by an inguinal hernia. Absolute certainty is reached if the finger can be introduced into the external abdominal ring and



Femoral hernia.

finds it empty, whilst the swelling below persists. H. S. Souttar (Brit. Med. Jour., Mar. 1, 1924).

Case of varix of the superficial epigastric vein simulating femoral hernia. The varix was not in the position in which it is commonly found when involving the termination of the long saphenous vein. Reduction of the tumor and compression over the femoral ring gave the impression that the swelling was permanently reduced. There was no thrill on palpation. There were a few dilated veins over the lower part of the abdomen, but no varicosities in the leg veins. W. Hughson (Surg., Gyn. and Obst., Mar., 1926).

**Enlarged Lymphatic Glands.**—These possess no neck, and several glands more or less enlarged can often be felt. Gurgling cannot be detected; fluctuation through the presence of

pus sometimes renders the diagnosis difficult.

*Psoas Abscess.*—Gurgling is also absent, but cough also causes an impulse, and the abscess often disappears as in hernia when the recumbent position is assumed. Spinal symptoms usually complicate such cases, however. If a psoas abscess exists, deep pressure in the iliac fossa will detect the tumor after apparent reduction.

*Varix of the femoral vein* is sometimes misleading, but pressure over it from below upward, sliding the finger over the vein until the femoral ring is reached, causes it to become emptied, after which it may be seen quickly to refill from below,—the differential feature.

*Cysts* are reducible, but coughing produces no impulse.

*Lipomata* are bosselated, have no impulse on coughing, and are more doughy to the touch.

*Hydrocele* and a thickened empty sac are difficult to differentiate, and sometimes require an exploratory incision.

**TREATMENT OF FEMORAL HERNIA.**—**Reducible.**—An appropriate **truss** involving the principles as to pressure, etc., already outlined, should be employed. A truss is not curative in the case of femoral hernia, however, and is often held in place with considerable difficulty. It should press diagonally upward toward the spine. Compression of the femoral vein, which lies externally to the hernia, must be avoided.

**Strangulated.**—A strangulated femoral hernia may sometimes be reduced by **taxis** when the thigh is flexed and rotated inward, which position causes the saphenous open-

ing to be relaxed peripherally. No excessive compression or upward pressure should be exercised, however, operation being less hazardous than such a proceeding.

**Radical Operation.**—Until recently femoral hernia has been regarded as less amenable to radical cure than inguinal; but the statistics would tend to disprove the correctness of this idea.

Numerous methods have from time to time been brought out; many of them are complicated and the majority of them have been supported by a very small number of cases. The inguinal method for the cure of femoral hernia, in which the opening is made in the inguinal canal and the femoral opening closed within the abdominal cavity, has been employed by a number of surgeons. It is, I believe, unnecessarily complicated, and, as long as almost perfect results can be obtained by the simpler methods, I think it should have no place in surgery. There is the additional risk not only of having a recurrence in the femoral region, but through the opening made in the inguinal canal. Various osteoplastic operations have been introduced by means of which the femoral opening is closed by a bony flap.

Most cases of femoral hernia, I believe, can be cured by one of the two following methods:—

1. **Purse-string suture of kangaroo tendon.** This suture is introduced first through Poupart's ligament, the outer part of which forms the roof of the crural canal, then passes through the pectineal fascia, the fascia over the femoral vessels, and lastly upward through Poupart's ligament, emerging about one-fourth centimeter from

the point of entrance. When this suture is tied it brings the floor of the canal into contact with the roof and completely closes the opening. It is very important thoroughly to free the sac before applying the ligature. I have employed this method in nearly 200 cases, with but a single relapse.

2. If the opening is very large, **Bassini's method**, which has given such admirable results for femoral hernia, may be employed: An incision is made parallel with Poupart's ligament and over the center of the tumor. This is the same incision that I employ in the purse-string suture. The sac is dissected free from the canal and ligated as high up as possible; with a curved needle six or seven sutures are inserted so as to unite Poupart's ligament with the pectineal fascia, thus accomplishing the same object that the purse-string suture does. The first suture is placed near the spine of the pubis; the second, half a centimeter externally; the third, one centimeter from the femoral vein, and the remaining sutures are so placed as to bring together the anterior and posterior walls of the canal.

In performing **femoral herniotomy by the inguinal route** the writer divides the external oblique aponeurosis through the internal pillar of the external ring; this makes it possible to cover the cord more completely in the last step of the imbrication method of Andrews. To facilitate dissection of the sac it may be necessary to make a vertical incision downward from the original incision and over the femoral swelling. The contents of the sac are reduced through an incision which, if necessary, may be carried clear to the neck of the sac. The empty sac is pulled upward through the femoral ring, a high ligation of the sac done, and the

distal portion removed. The external iliac vein is now retracted outward and the inner aspect of the femoral ring exposed and obliterated by 3 chromic catgut sutures, 2 of which are passed through Cooper's and Poupart's ligaments, and the third through Cooper's and Gimbernat's ligaments. The inguinal canal is closed by the Bassini or the Andrews imbrication method. Eisendrath (*Surg. Clin., Chicago, iv, 49, 1920*).

Series of 108 cases of femoral hernia operated on by **Kummer's method**; it included 56 strangulated cases. The incision is 1 or 2 cm. below Poupart's ligament. After the sac is closed and ligated, Reverdin's needle is inserted through the abdominal wall, 2 or 3 cm. above Poupart's ligament. With the stump of the sac pushed back, the needle is passed close to the pubic border and below Cooper's ligament. The obliquus and transversalis are brought down on this ligament by 1 or 2 U-sutures, and thus close off the femoral canal from the abdominal cavity. The mortality was 7.3 per cent., limited to cases of strangulation. Among 66 cases traced 3 or more years later there were only 4 recurrences. Piotrowski (*Lyon chir., Nov.-Dec., 1921*).

**Intra-abdominal route** used in over 300 cases of inguinal and femoral hernia without a single recurrence. After removal of femoral hernias there is little need of obliteration of the neck or canal. An incision is made just above the internal inguinal ring and the internal oblique and transversalis fibers and fascia separated in the usual way. The peritoneum is then opened and the neck of the hernia exposed. With finger or forceps in the hernial sac, enucleation, aided externally by a gauze-covered finger or sharp dissection, is easily accomplished and the femoral and large vessels made safe from injury. The inverted sac is excised and the edges sutured and tacked to the internal inguinal ring and the edge of the original peritoneal incision, so that the raw surfaces of peritoneum are transplanted away from the

femoral canal. The split muscles are loosely sutured without undue tension. LaRoque (Ann. of Surg., Jan., 1922).

New operation for femoral hernia intended to prevent the troublesome defects which follow operation for reduction when the ring is very large and rigid or when it has to be enlarged at operation. The writer closes the upper end of the femoral canal with a **strip of the aponeurosis of the external oblique** muscle by turning it into the space and attaching it to the periosteum of the pubic bone just above the pectineal line. The upper fragment of the external oblique is sewed to Poupart's ligament. The procedure is described as follows:

The skin incision begins over the external inguinal ring and extends about 6 cm. upward and outward, parallel to and about 2 cm. above Poupart's ligament. The external oblique aponeurosis is exposed and its fibers split upward from the ring for a distance of  $\frac{3}{4}$  cm. This splitting should begin at the margin of the ring farthest from Poupart's, leaving a strip of the aponeurosis about 2 cm. wide attached to Poupart's. The internal oblique is now separated by blunt dissection and, together with the spermatic cord or round ligament, retracted upward. The transversalis fascia, rather thin at this point, is torn through, and the neck of the sac exposed. The sac is pulled out of the canal, emptied, and excised. A few sweeps of the sponge will now clear out the upper end of the femoral canal, and a single deep abdominal retractor placed in the upper side maintains adequate exposure. A deep space is left, bounded above by the internal oblique muscle superficially and the peritoneum more deeply. Both are held by the retractor. Below is the pubic bone, and more superficially, Poupart's ligament, with Gimbernat's ligament joining the two in the mesial part. Laterally lies the external iliac vein, with the deep epigastric vessels just above it. Care must be taken in cleaning out this space not to injure an anomalous ob-

turator artery, which sometimes runs right across the field.

The lower fragment of the external oblique aponeurosis is now turned inward into this space and attached to the periosteum of the pubic bone just above the pectineal line. Two or three silk sutures are necessary, the innermost next to Gimbernat's, and the other close to the external iliac vein. This produces a firm closure of the upper end of the femoral canal with a strong durable membrane. The floor of the inguinal canal is now closed. One kangaroo tendon stitch in the conjoined tendon, surrounding Poupart's and going under the cord or round ligament, is usually enough. Next, the upper fragment of the external oblique is sewed to Poupart's with a running stitch, care being taken that each stitch includes not only the turned-in lower fragment but a part of Poupart's as well. The skin is closed with clips. Edmund Andrews (Ill. Med. Jour., Apr., 1923).

Contrary to the impression one receives from text-books, femoral hernia is of comparatively rare occurrence. Only 85 in the writer's series of 2468 hernia operations, or 3.4 per cent., were for femoral hernia. Practically all of the cases were dealt with by the purse-string method after removal of the sac, and there was only 1 recurrence. J. P. Hoguet (Surg., Gyn. and Obst., July, 1923).

## UMBILICAL HERNIA.

**VARIETIES.**—Three forms of umbilical hernia are usually recognized: the *congenital*, due to faulty union of the visceral plates in the middle line; the *infantile*, which occurs soon after birth as a result of yielding of the umbilical cicatrix after separation of the umbilical cord; and the *adult*, which usually presents itself late in life in women who have borne many children.

The author divides hernia at the umbilicus into three varieties, ac-

cording to the time of its appearance. Embryonic umbilical hernia occurs within the three first months of fetal life, and is due to a failure of development of the ventral plates, which never close. Such a hernia has no skin envelope, and is covered by a thin membrane derived from the amnion, an internal serous membrane, and a gelatinous substance between. The liver is often seen in the tumor, which has no sac. The author reports a case of this variety in which the heart was almost vertical in position. The second type of congenital hernia occurs in the later months of fetal life; it is covered by the skin, and has the regular number of envelopes; it is due to non-adherence of the ventral plates at the umbilicus. This form is much less serious than the other. In a paper by Berger, 32 operations are cited, with 26 cures and 6 deaths. The third form is the ordinary one often seen in weak, premature infants; it is of small size, at the navel. Its treatment consists of placing a proper pad and bandage about the body, to be worn for less than four years at most. If spontaneous cure has not taken place by that time operation is in order. Kirmisson (*Med. Rec.*, Feb. 4, 1911).

**Congenital Umbilical Hernia.**—In this variety the contents can often be seen through the hernial coverings, owing to the thinness of the layers. The hernia, though usually very small, is sometimes quite large from the first, and contains the greater part of the abdominal organs.

Strangulation may occur at the neck through compression of the surrounding tissues, but it has also been caused traumatically by the cord applied around the funis at birth, leading to a fatal issue if much intestine is involved. A fecal fistula results if but a small portion of gut is lost.

Appendix found in an umbilical hernia in a child 5 years old, operated

for a tumor and fistula at the navel. In addition to tuberculous peritonitis, there was found a tuberculous inflammation of the appendix. Flörcken (*Munch. med. Woch.*, Oct. 7, 1907).

Case of hernia of the liver into the umbilical cord, noted during delivery. There was seen a livid mass about 3 inches in diameter, projecting into the much thinned cord which led from the summit of the mass. The hernia projected about 2 inches. Upon opening the sac, the entire mass was found to be the liver, dome forward, free of attachments except to the cord, to which it was fastened by a cobweb-like strand of tissue starting from its crest. G. H. Reese (*Va. Med. Mthly.*, June, 1925).

**Treatment.**—Immediate reduction should be practised if possible, and retention of the intestine insured by the application of adhesive strips over a small pad placed over the opening. Many surgeons advise immediate closure of the edges of the ring by catgut sutures. The operation is simple and effective.

**Simple laparotomy, with extirpation of the sac and suture of the freshened borders of the wound**, is sufficient, according to Cumston, in a large majority of cases of congenital hernia. Congenital umbilical hernia should be operated on as soon as possible after birth, because desiccation of the sac will soon become the starting point of inflammatory attacks in the viscera. Upon prompt and careful operation, babies will stand the operative shock and anesthesia well.

Case of congenital umbilical hernia in which the sac contained the entire small intestine and the cecum firmly united by adhesions. The child was operated on when only 3 hours old, and recovered. S. S. Wilson (*Western Med. Rev.*, April, 1907).

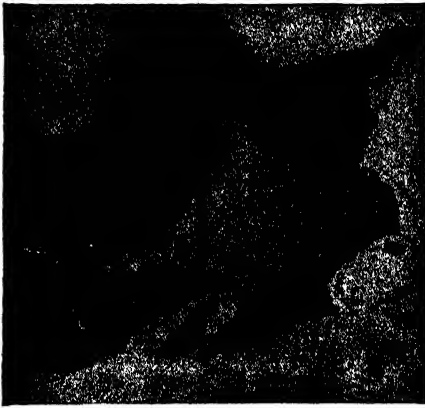
Case of a child born with a very large inoperable umbilical hernia, and still living at the end of two years and four months. The treat-



ment used was the application of moist warm compresses. Durlacher (Munch. med. Woch., March 17, 1908).

Review of the reports of 160 cases of congenital umbilical hernia in literature showing that 126 were operated upon, of which 84 recovered and 40 died (results in the other cases not known). W. E. Magrude (Med. Record, Sept. 5, 1908).

Description of a method used by **Nota** for umbilical hernia in 244 children from 2 months to 9 years old. An elastic cord thirty or forty centimeters long is carried around the



Large umbilical hernia in an infant.

base of the hernia with a long, curved needle passed horizontally under the skin. The hernia is reduced and held with the finger while the cord is being drawn tight and the opening obliterated. The ends of the cord are held with a clamp, tied with silk close to the skin and cut off. In a few days the cord cuts through the soft tissues, which grow together in its wake, thus solidly closing the opening, and after twelve or fifteen days the entire cord comes out through the hole in the skin where the ends of the cord protrude, and a thick, solid cicatrix is left. After ten days a dry dressing is applied, and a cloth binder should be worn two or three months afterward. The elastic cord is sterilized by soaking for an hour in 70 per cent. alcohol containing 1.5

per cent. glacial acetic acid. Recurrence observed in only 1 case, cured later by repetition of the procedure. For children other than infants, **Nota** uses **ethyl chloride**. Brun (Archives de méd. des enfants, Sept., 1912).

**Infantile Umbilical Hernia.**—This form of hernia, though freely met with, never leads to strangulation and quickly subsides by contraction of the opening if, after reduction, appropriate retentive measures are resorted to.

**Treatment.**—The hernia should be reduced, then held in place by means of a cork pad wrapped in cotton wadding, held *in situ* by adhesive strips. When these irritate the skin, or the hernia seems rebellious, a light truss can be utilized instead.

In the small umbilical hernia frequently appearing between the sixth week and third or fourth month of life, the author uses a **roller bandage** of moderately heavy flannel two to two and one-half inches in width and sufficiently long to make three and one-half turns of the body. It is applied by spreading one end upon a table and so placing the child upon it in the recumbent position, that the free end can be brought forward to a point above the iliac spine, directly opposite the navel. This end is now used as a point of resistance in applying firmly but not tightly the first turn of the bandage, which is made to pass exactly over the navel and to grasp the opposing part of bandage as it completes the first turn. The second layer passes a little less than an inch lower than the first, so that its upper margin well covers the umbilicus; the third layer, one inch above the first. The bandage can be adjusted and readjusted according to the needs of the case, once the mother has carefully studied the principle of its use. A. S. Bleyer (Interstate Med. Jour., June, 1908).

Case of a child 6 years old in which the left lobe and most of the right

lobe of the liver were found prolapsed into the cord. The round ligament, found to be holding it, was ligatured and cut and the liver fell back into position. Three deep transverse silkworm-gut sutures were passed through the recti muscles, which were firmly approximated, the umbilical vessels ligated, and the thickened edges of the navel trimmed and sutured, making a vertical wound. A perfect cicatrix was obtained. Mitchell (*Lancet*, May 13, 1911).

Report of 6 cases of hernia of the umbilical cord, of which 5 were operated upon, usually on the first day of life. That 4 out of 6 children were saved argues for immediate and radical operation. W. Hannes (*Münch. med. Woch.*, Nu. 50, 1911).

In a child 9 days old seen by the writer, the navel showed a sloughing mass about 4 centimeters in diameter. Although the child had a general peritonitis, nothing remained but to resect about 8 inches of small bowel and a portion of the ascending colon. The anastomosis soon healed satisfactorily. The child, however, died on the eighteenth day from the peritonitis. Cullen (*Trans. Amer. Gynec. Soc.*; *N. Y. Med. Jour.* Aug. 17, 1918).

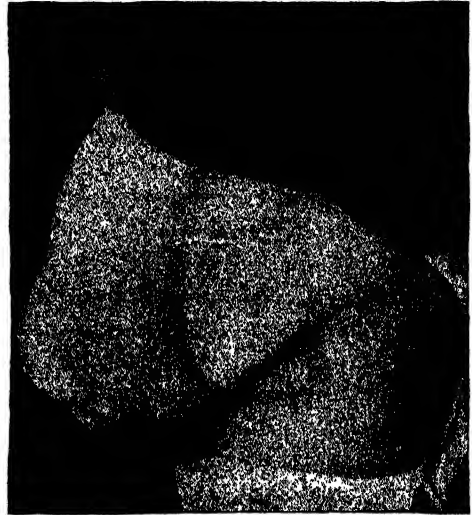
**Adult Umbilical Hernia.**—This variety of hernia protrudes through the linea alba not far from the umbilicus, and is generally observed in stout people, especially women.

Umbilical hernia in the adult may attain enormous proportions, hanging down like a large pouch if allowed to go untreated. The omentum, transverse colon, and small intestines may all be found in it.

**Treatment.**—When reducible, the hernia is held with difficulty by **trusses**, especially in large subjects. A **broad belt with a pad** fastened to it is sometimes more effectual. It is frequently irreducible, however, and is prone to inflammatory manifestations. When it cannot be reduced, it

is best to protect it by means of a **cup-shaped pad** held in position by a bandage or a belt.

Plea for **early operation** in umbilical hernia. The treatment must practically be prophylactic, viz., must be applied not only before there is any strangulation of the viscera, but before the hernia becomes of extensive proportions. J. W. Kennedy (*Jour. Amer. Med. Assoc.*, Dec. 21, 1912).



Large umbilical hernia.

This variety of hernia is also liable to become obstructed, a complication occasionally leading to strangulation. There is local disturbance and sometimes pain; vomiting sets in and the other manifestations of strangulation already described present themselves.

**Taxis** should be tried and, if care be taken to empty the hernial intestines of all gas by gentle pressure, often succeeds. If it should not, however, the proclivity of the hernia to rapidly become gangrenous, owing to compression of its vascular supply, renders an **immediate herniotomy** advisable.

Obesity and advanced years are no contraindication in umbilical hernia

to operation. Attempts at reduction should be very cautious, as there is a special tendency to gangrene in these cases. Eschenbach (*Archiv. f. klin. Chir.*, Bd. lxxxvi, Nu. 1, 1908).

Button-strapping is never indicated in umbilical hernia in adults. An **abdominal belt** is, however, often helpful. Umbilical hernias in children up to the age of 12 should be treated by **strapping**. No case should be subjected to operation until a fair trial with the button has failed, and as a rule surgery should be postponed until the child is 10 or 12 years old. Coley (*Internat. Jour. of Med. and Surg.*, Feb., 1925).

When **operation** becomes necessary, the skin should be divided over the orifice, remembering that the sac is exceedingly thin and that it may readily be penetrated. Adhesive inflammation often causes the contents to be adherent, another complicating circumstance. To overcome the constriction without opening the peritoneum should be the first aim; if this is impossible, a couple of shallow incisions through the fibrous ring at its lower border, from the inside of the sac, will generally make it possible to reduce the strangulated loop. The adherent omentum should then be liberated, ligated, and removed, and its stump returned. After freshening the pillars of the ring and suturing, the wound should be closed and drained. Should the gut be gangrenous an artificial anus is the only resort.

**Mayo's operation** for umbilical hernia is described by its originator (W. J. Mayo) as follows: Two transverse elliptical incisions are made, exposing the neck of the hernial sac and the aponeurotic structures for several inches above and below it. The neck of the hernial protrusion is cleared as high as the aponeurotic structures extend. The sac is then opened and any intestine which may lie in it is returned into the ab-

domen. Omentum, if present, is ligated in sections on a level with the peritoneal cavity. The sac, with all of the adherent omentum and skin, is now cut away. A stout curved needle threaded with strong linen is passed from without in through the aponeurotic structures and peritoneum from two to three inches above the margin of the opening. To guard the needle as it enters the peritoneal cavity the bowl of a large tablespoon is a valuable aid. The needle and thread is drawn down and out of the hernial opening. A firm mattress stitch is now caught in the upper edge of the lower flap about one-fourth inch from the margin, the needle carried back through the hernial opening into the peritoneal cavity and made to emerge one-third inch lateral to the point of original entrance. On each side of this is introduced a similar mattress suture of strong chromicized catgut. These three sutures are drawn tight, pulling the entire thickness of the aponeurotic and peritoneal structures behind the upper flap. The margin of the upper flap is now retracted to expose the suture line, and if any gap exist it is closed with catgut sutures. The upper flap is then sutured to the surface of the aponeurosis below by continuous chromicized catgut suture and the superficial fat and skin closed. The patients are confined to bed from twelve to twenty days. Of 75 patients operated, but 1 had a partial relapse.

Having made the transverse or longitudinal elliptic incision and dissected the sac free from the fascia until the outer layers of the hernial ring are exposed on all sides, the writer makes a small longitudinal incision through the fascia and peritoneum just above the ring. A finger is then introduced, and under its guidance the hernial ring is cut loose all around. The operator is then able to lift the hernial sac well away from the abdominal wall and wall it off. When the sac contains only omentum and this is densely adherent, the incarcerated portion of it is tied off and removed with the sac. Sometimes the omentum is free and can be readily pushed back into the abdomen. The ring is then closed by the overlapping method. If intestinal loops are continued in the sac, it is usually easy to

open up the main sac and its alcoves, starting at the neck and traveling outward. Occasionally the loops have to be literally dissected away from the sac wall, leaving many bleeding points on the bowel. In a case the writer reports, in a man of 78, the adhesions were so dense and numerous that this could not be done. The sac wall, consisting of a thin fascia and the peritoneum, was disregarded and the loops of bowel simply cut apart until all had been unraveled, leaving 30 to 40 patches of sac adherent to intestinal loops. The loose edges of these patches, smooth and free of hemorrhage, were trimmed off with scissors. With the usual overlapping method, recovery followed, and 3 years later the patient was still in good health. T. S. Cullen (Jour. Amer. Med. Assoc., Feb. 25, 1922).

In extensive umbilical hernias the author recommends the use of a **bronze wire**, passed about the umbilical ring. It is drawn tight while an assistant exerts strong traction upon forceps to pull upward the lips of the circular ring. This procedure leads to the formation of a fibrous button, which completely blocks the former opening. The wire can be easily removed several weeks after the operation. P. Moure (Jour. de chir., Apr., 1922).

In operating for umbilical hernia, the writer first makes the customary transverse elliptic incision surrounding the umbilicus, carried down to the anterior sheath of the rectus muscles. The neck of the sac is isolated, the sac opened, and its contents dealt with as required to secure reduction. The sac and skin immediately about the umbilicus are then excised, leaving only a narrow margin of peritoneum about the hernial orifice. The latter is not enlarged, but is closed by mattress sutures of strong silk or catgut so as to convert the oval or round orifice into a straight transverse line of closure. The second row of sutures is also a series of interrupted mattress stitches, overlapping the first row, which they bury, and forming another

transverse line of closure over the first. The span of each of these stitches is about 1 cm. wider than the first row of stitches, so that when they are tied an inverted buttress of anterior sheath, about 1 cm. in depth, is turned inward over the first layer of closure. The second row begins well laterally to each end of the first row, which merely closed the hernial orifice. H. B. Stone (Arch. of Surg., Feb., 1926).

### VENTRAL HERNIA.

"Ventral" is a general term applied to hernias occurring in parts of the abdomen other than the umbilicus, especially those following operative procedures, such as laparotomy. It may also result from abscess of the abdominal wall, defective development, muscular rupture, etc. Strangulation is rarely witnessed, owing to the nature of the orifice. The treatment is that recommended for umbilical hernia.

Stanton, after 500 personal laparotomies, noted 24 post-operative hernias all ascribed to weak union of the fascial layers anterior and posterior to the rectus muscles. Below and above the fold of Douglas the transversalis fascia and peritoneum together form the first line of defence. If the fascia is not properly united, the overlying muscle yields, leaving only as defence the fascia of the anterior sheath. Between the posterior sheath and peritoneum is often  $\frac{1}{2}$  inch or more of fat. In such cases it is often better to use a second continuous suture for this fascia.

The thorax is an ideal place for obtaining a **pedicled flap**, there being no danger, on account of the ribs, of weakening the parietes. In 2 unusually large *postoperative* hernias in the upper abdominal wall, he turned down flaps from the pectoral fascia. In a third, flaps were taken from the external oblique aponeurosis. R. E. Farr (Surg., Gyn. and Obst., Feb., 1922).

The majority of post-operative ventral hernias follow sepsis, which is unavoidable in many cases, mainly

owing to prolonged drainage, and, as secondary factors, paralytic ileus, vomiting, coughing and sneezing. In some cases the condition is due to improper closure or to allowing a patient to sit up or leave the hospital too soon. In a series of 512 cases of such hernias, 33.78 per cent. occurred in low middle-line incisions—about the only location, in the writer's experience, where such hernias occur without a preceding infection. To reduce the frequency of these hernias, and also reduce operative mortality, he emphasizes the pre-operative medical management of obese persons with pendulous abdominal walls; they should be kept in bed on a restricted diet with increased elimination in order to reduce weight and lower blood-pressure. Of 28,270 abdominal operations performed at the Mayo Clinic during the 5 years ending with 1919, 2.05 per cent. were for post-operative ventral hernia.

The size of the hernia is no guide to the amount of trouble it may give; a small opening through which a single knuckle of bowel or tag of omentum may become incarcerated or strangulated is often much more dangerous than a large opening through which a large quantity of abdominal contents protrudes and may even be adherent or irreducible. In most cases the sufferer puts up with the deformity by wearing a **belt or truss**. Others submit to **operation**. Pre-operatively, in massive hernias, particularly in stout subjects, under **rest in bed and diet**, 20 to 30 pounds can be taken off in 3 to 6 weeks. During this time the hernial protrusion is returned and retained in the abdomen by careful application of **bandages**. At operation, an anatomical closure without undue tension is generally not possible. In these cases a **plastic overlapping**, on the same principle as the Mayo operation for umbilical hernia, is advisable. All fat must be removed from the surfaces to be apposed, and no dead space must be allowed. If possible the overlapping should be vertical rather than

transverse. Excessive overlapping, causing undue tension, must be avoided. Twenty-day chromic catgut No. 1 or 2 is the suture material of choice. "**Living sutures**" from the **fascia lata** add materially to the strength of the closure. Tension sutures of silkworm gut increase security if the abdominal walls are thin, and may remain 15 to 18 days; but in the very obese they are often a serious danger, cutting in and increasing the risk of infection.

Of 596 cases operated upon, 22.48 per cent. still had weak wounds with more or less bulging, but only 5.7 per cent. complained of slight inconvenience and 3.35 per cent. reported no improvement. The mortality was 1.78 per cent. J. C. Masson (*Surg., Gyn. and Obst.*, July, 1923).

Post-operative ventral hernias in obese subjects, especially if large and with musculo-aponeurotic deficiencies, are not always successfully operated upon. An **abdominal belt** with an inner pad which covers the bulge seems to be the method of choice. **Living sutures**, popularized by Gallie, represent the greatest single advance in 2 decades in the management of direct hernia, recurrent inguinal hernia, and umbilical and ventral hernia. A piece of fascia lata from the external surface of the thigh is removed and split into  $\frac{1}{4}$ -inch strips. The sutures become an integral part of the repair, and tension, the bugbear of all hernia operations, is avoided. Large openings can thus be filled in with strong living tissue. Coley (*Internat. Jour. of Med. and Surg.*, Feb., 1925).

**Shortening, overlapping or transplanting** of the recti muscles recommended as a useful adjunct in the treatment of all ventral hernias. The recti are detached from the pubes and can be shortened, if required, by making a tuck; they are then sutured to the symphysis, or can be overlapped and sutured with kangaroo tendon to the pubes after holes have been drilled in the bone. Nuttall (*Brit. Med. Jour.*, Jan. 23, 1926).

**EPIGASTRIC HERNIA.**—This is a general term applied to forms of hernia occupying the space between the end of the sternum and the umbilicus.

These tumors are sometimes discerned with difficulty, and are apt to cause symptoms usually referred to gastric disorders.

The subjective symptoms of epigastric hernia may include colicky pain, nausea, sour stomach, distress after eating, occasionally vomiting, and a dragging sensation in the abdomen, due to traction on the parietal peritoneum or the falciform ligament. A small tumor, sometimes no larger than the tip of the little finger, should be looked for just above the umbilicus, to the left of the median line, or, rarely, in the center or just to the right of the median line. In about 25 per cent. of epigastric hernias with symptoms, there are objective gastric disturbances, most frequently hyperacidity, lessened motility, gastroptosis and dilatation. Small *hernias in the linea alba*, especially the epigastric variety, must be distinguished from peptic ulcer and cholelithiasis. In hernia the paroxysmal attacks are unrelated to the meals but usually follow physical exertion, and the patient finds most relief in a doubled-up position, which relaxes the linea alba. When with the hernia there are gastrointestinal symptoms, even if mild, X-ray examination is important because of the frequent association of gastroduodenal ulcer with this variety. Sometimes when the examination is negative it is advisable to do an exploratory laparotomy at the time of hernioplasty. L. F. Watson (Med. Jour. and Rec., Apr. 16, 1924).

The size of the hernia and the consequent disability are of much interest, the hernias ranging in size between that of an egg and a child's head. The weakness and discomfort caused by these hernias are very

much the same as in hernia following laparotomy.

In regard to the treatment of such cases, much depends on the age of the patient, as well as upon the character of the abdominal wall. As a rule, these patients are young adults with good abdominal muscles, little accumulation of fat, conditions the contrary of which is usually found in umbilical hernia.

The results of **operations** for epigastric hernia are very satisfactory. The same is true of cases following appendicitis. Of 4 cases not one relapsed, though the hernias dealt with were of large size and adhesions were present.

Epigastric hernia found to be comparatively frequent in children. There occur periodic pains in the abdomen, directly connected with the meals, especially after breakfast. One of the appendices epiploicæ has worked its way through the linea alba, with consequent traction on the peritoneum. If the hernia persists after systematic use of a **rubber pad** held in place by long wide strips of adhesive plaster, the author advises correction by **injection of paraffin** or a **radical operation**. Brandenberg (Archiv. f. Kinderheilk., Bd. lviii, Nu. 1-3, 1912).

**CECAL HERNIA.**—This form of hernia is far more frequent than is generally supposed. I have observed it 16 times in 531 operations. In a number of cases the cecum could be reduced, but the appendix could not, on account of adhesions to the sac. Cecal hernia occurs usually on the right side, but may be found on the left. I have operated upon one left inguinal hernia in which the sac contained a large vermiform appendix. The patient was 10 years old. In the majority of cases, especially in young subjects, the hernia is congenital.

The mobility of the cecum and its proximity to the internal ring easily permit its entrance into a patulous vaginal process, either before or after birth, forming an inguinal hernia with a congenital sac. Attachment to the gubernaculum testis or testis itself may drag the cecum into the inguinal canal.

Acquired inguinal hernia of the cecum may be classified as (1) simple, and (2) gliding or sliding. The latter may be subdivided into (a) the intrasaccular; (b) the extrasaccular or parasaccular, and (c) the sacless.

The gliding cecal hernias are produced by a ptosis or downward gliding not only of the cecum but also of the colon, its attachments and vessels, and the posterior parietal peritoneum. About one-sixth of the reported cases of all varieties of inguinal hernia of the cecum were found on the left side. Femoral cecal hernia is generally found in the female sex. Inguinal hernias of the cecum are found at all ages, but are more common at the extremes of life. The symptoms are not characteristic. Strangulation is uncommon.

No single method of dealing surgically with the sac and intestine is applicable for all cases, and the surgeon must be guided by the conditions in each individual patient. The sacless hernias are always small, but usually it is possible, if deemed advisable, to secure a peritoneal covering by a slight modification of **Berger's method** of forming a meso-cecum for extrasaccular hernia. **Carnett** (*Annals of Surg.*, April, 1909).

Fifteen authentic cases of periceal retroperitoneal hernia have been reported, 8 being of the subcecal and 7 of the ileocecal variety. Of the latter group only 2, of the former, 3 patients recovered. There are few, if any, features pointing to a distinctive diagnosis. **Matthews** (*Annals of Surg.*, May, 1910).

#### RARE FORMS OF HERNIA.—

**Diaphragmatic Hernia.**—This form may be *congenital* or *acquired*. The

congenital form is due to imperfect closure of the diaphragm and protrusion into the pleural cavity of a portion of the abdominal contents. This occurs by the side of the ensiform cartilage, between the xiphoid and costal portions. The diagnosis is hardly feasible except by X-ray.

In congenital diaphragmatic hernia the abdominal organs usually pass in early life into the chest, but symptoms may first arise at any period of life. Dyspepsia and feeling of fullness and cyanosis may occur after meals, followed by rapid recovery. Or, there may be great respiratory embarrassment or strangulation of the intestine.

Most cases are discovered *post mortem* or during operation for some other condition; some (16 per cent.) become apparent on operation for internal strangulation of the intestine. In view of the large proportion of cases which pass through life without serious trouble surgical treatment is to be resorted to only where acute strangulation occurs. **E. B. Leech** and **C. H. S. Redmond** (*Med. Chronicle*, April, 1909).

Report of the clinical history and autopsy findings in a man aged 70 years who died as the result of a congenital deficiency in the central tendon of the diaphragm. The opening was connected directly with the pericardial cavity, the heart at autopsy being surrounded by the entire transverse colon and the great omentum. The patient had never been confined to his bed by sickness before, and on admission presented the clinical picture of an acute right-heart dilatation. The autopsy showed the conditions described, together with evidences of irritation and inflammation in the small intestine, with contiguous reddened and thickened peritoneum. There was no hernial sac. **H. S. Martland** (*Jour. Amer. Med. Assoc.*, May 15, 1909).

The acquired form may be due to rupture of the diaphragm through

violent effort, direct violence, or penetrating wounds. The penetration through the opening thus formed suddenly creates dyspnea and asphyxia, besides other manifestations which the displacement of organs gives rise to according to the site of the tear or laceration in the diaphragm. Excessive thirst has been noted by Bryant as a prominent symptom.

The most important symptoms of acquired diaphragmatic hernia are: (1) displacement of the heart to the right; this was evident to some degree in all of the cases reviewed; (2) metallic tinkling heard high up in the chest, having relation to the peristaltic movements of the stomach, and not especially corresponding in time to the respiratory movements; (3) tympany of some degree high up in the left chest; (4) absence over the left chest of the dull note indicating fluid, or of the hyper-resonant note of pneumothorax. Murray and Morgan (*Lancet*, Dec. 8, 1917).

Gerster has reported a case of intercostal diaphragmatic hernia, which is relatively rare. The hernial opening in these cases may be as large as the tip of a finger or large enough to admit the entire hand. The hernias vary from the size of a pea to that of an ostrich-egg; usually no sac exists.

Gerster believes the treatment should be mechanical or operative. If operation is done, the procedure should be varied according to the conditions found in the individual case. In some cases, one is not able to make a **layer suture of the diaphragm and intercostal muscles**; in others, one has to **approximate the ribs** above and below, obliterating the space through which the hernia formerly protruded; in others still, a **plastic closure** may have to be resorted to.

Summing up, Gerster states: "In-

tercostal diaphragmatic hernias (1) are usually of traumatic origin; (2) they occur mostly on the left side in the anterior portion of the intercostal spaces (sixth to tenth inclusive)—a region lying between the lower margin of the lung and the free border of the rib from the midline to the mid-axillary line; (3) their symptoms are those common to hernias in general; (4) the X-ray is of great value in determining the relationship of the various parts of the alimentary canal to the hernias; (5) the details of operative treatment vary with the finding in individual cases."

Among recent operated cases of diaphragmatic hernia, the writer found 10 recoveries in 11 operations. In acute injuries, the abdominal route permits better inspection and repair of viscera. The thoracic route is indicated in recent stab wounds of the chest. Simple enlargement of the wound with resection of a rib or 2 may prove sufficient. J. F. Mitchell (*Trans. So. Med. Assoc.; N. Y. Med. Jour.*, Apr. 21, 1917).

Keith's own remarks are based on a study of 34 museum specimens in London, 26 of which were of congenital and 8 of acquired hernias. The congenital hernias, he states, are chiefly those which occur at the unclosed pleuroperitoneal passages, of which there were 21, the other 5 being formed by developmental extrusion of the abdominal viscera, principally liver, through the septum transversum. In a certain proportion of the congenital cases he believes it possible to adopt surgical measures for the cure of the condition present.

The instances of patients with congenital diaphragmatic hernia living to adult life are relatively rare.



According to Cranwell, most diaphragmatic hernias have no hernial sac, hence may properly be called prolapses (220 out of 248). Congenital hernias have a sac, as have also those passing through the esophageal or parasternal orifices. Diaphragmatic hernia is usually due to a direct wound, sometimes to traumatism without a wound. The stomach is the organ oftenest herniated, followed in order by the colon, small intestine, and omentum. In small wounds the omentum usually prolapses first and acts as a guide for the transverse colon, stomach, and spleen. As the stomach is dragged up it undergoes torsion, producing more or less obstruction at both orifices. Usually there is, immediately after the accident, pain in the epigastrium and the left hypochondrium, with a tendency to radiation toward the left shoulder, soon associated with digestive troubles; at times dyspnea and palpitation, with physical signs, and when the hernia is large, with a marked depression in the epigastrium and enlargement of the left side of the chest. Insufflation of air into the stomach and rectum, by increasing thoracic tympany and bringing on dyspnea and palpitation, may often prove valuable in diagnosis. Fluoroscopy has often been helpful. Displacement of the heart is always suggestive.

Congenital diaphragmatic hernia occurs much more frequently than is generally supposed. X-ray offers the best means for diagnosing these cases. Hernial protrusion is usually through a defect in the left side of the diaphragm.

In the case reported by the writer, hernia occurred through the esophageal opening. The greater curvature of the stomach was drawn through the esophageal opening, an **anterior gastro-enterostomy** performed and the stomach was anchored to the esophageal opening by silk sutures. The patient was discharged symptomatically cured. W. A. Downes (Surg., Gynec. and Obstet., xxvii, 393, 1918).

Four types of congenital diaphragmatic hernia are recognized by the writer, *viz.*, through the hiatus pleuroperitonealis, the dome, the esophageal opening, and absence of the left half

of the diaphragm. In 35 such cases the ratio of these 4 types was 1, 18, 12, and 4. **Operation** through the chest is advised, the results being, however, merely palliative. J. B. Hume (Brit. Jour. of Surg., Oct., 1922).

Case of a man wounded in the chest in 1916, who in 1917 began to have attacks of severe epigastric pain, supplemented 2 years later by vomiting. A pneumothorax at the left base was found, and the X-ray showed most of the stomach above the diaphragm. The author took out 6 inches of the eighth rib in the postero-lateral region, reduced the stomach into the abdomen, and closed the edges of the tear in the diaphragm with as much overlapping as possible.

Another case observed was that of a man struck in the upper abdomen by a dehorned bull. The blow at once led to epigastric pain, nausea, vomiting, hiccough, dyspnea, pain on respiration, and shock. There was marked rigidity of the upper left quadrant, with immobility, tympany, and positive coin test in the lower left chest. X-ray examination was confirmatory, and the aperture was satisfactorily closed by operation as in the first case. Usually the thoracic route of approach is easiest in such cases, but the writer advocates an incision on the antero-lateral surface extending both into the chest and abdomen; this procedure makes rib excision unnecessary. C. B. Keenan (Ann. of Surg., May, 1922).

Wide divergence prevails as to the relative merits of approach when *strangulation* of a diaphragmatic hernia has occurred. In the writer's opinion, the condition of the patient at the time he is first seen should determine largely the decision. Where symptoms of strangulation and ileus are apparent, the abdominal approach is an absolute necessity.

Where the case is a chronic one, and the diagnosis has been clearly established and confirmed by X-ray before operation, the combined approach is indicated. The abdominal incision should be made first, and if

reduction can be successfully performed, and access can be had to the rent in the diaphragm, it may not be necessary to open the chest. Binnie, who analyzed the relative mortality in 52 traumatic cases, found that in the non-strangulated cases the operative mortality of the thoracic route was 9.6 per cent., while that for the abdominal route was 50 per cent. When strangulation had occurred the mortality from the thoracic route was 50 per cent., and from the abdominal, 100 per cent.

From 1918 to 1920, inclusive, 96 cases of diaphragmatic hernia were reported, of which 43 were the result of battle casualties during the World War. J. L. Crook (*Med. Jour. and Rec.*, Jan. 2, 1924).

In 54 non-traumatic diaphragmatic hernias the most constant symptom was substernal pain with regurgitation when in the supine position. Next came vague gastric distress, sometimes with tenderness referable to the right upper quadrant or pain radiating to the back as in gall-stones. Less common were matutinal vomiting with hyperacidity, dyspnea with palpitation, and rarely, difficulty in swallowing solid food. T. R. Healy (*Amer. Jour. of Roentgenol.*, Mar., 1925).

**Properitoneal, or Interstitial, Hernia.**—There are three varieties of interstitial hernia, according to the relative position of the sac:—

1. The sac lies between the peritoneum and the transversalis fascia. This variety is very rare. A tumor is seldom present, and the condition is not often recognized until strangulation has occurred.

2. The sac lies between the external and internal oblique muscles.

3. The sac is external to the aponeurosis of the external oblique.

In the last two varieties there is a well-marked tumor which is situated in the inguinal region, but seldom extends into the scrotum. While the

mode of formation is in many cases difficult to explain, in most instances the condition is associated with and probably dependent upon an undescended or partially descended testis. In the rare cases of this variety of hernia observed in women it has been associated with a hydrocele of the canal of Nuck; the undescended testis or the hydrocele, furnishing an obstruction to the farther progress of the hernia in the downward direction, causes it to enlarge upward, and, following the line of least resistance, the sac may find its way to the situations already described.

The conditions which may simulate this form of hernia are: a cold abscess from spinal or pelvic bone disease, and hydrocele of the cord. The only form of treatment to be recommended is the operative.

A true fat hernia is a protrusion of a properitoneal fat mass or lipoma through one of the ordinary hernial apertures. The onset may be sudden. Although not reducible, these hernias are capable of a seeming reduction in a fair proportion of cases. An impulse on coughing can usually be obtained. In very rare instances symptoms of strangulation may result from torsion. The treatment of fat hernia differs in no way from that of the ordinary type. J. Ransohoff (*Lancet-Clinic*, Jan. 4, 1913).

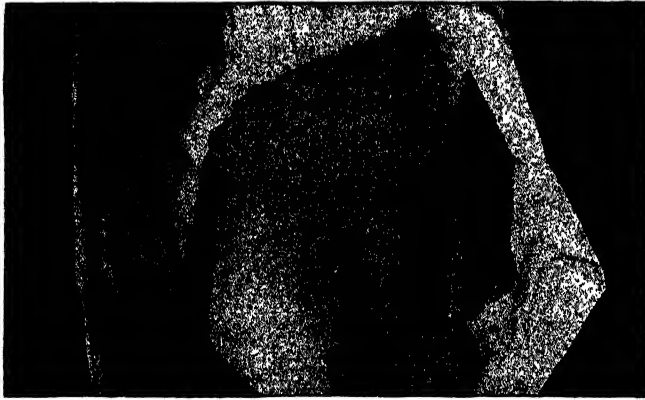
**Lumbar Hernia.**—This rare form of hernia emerges in the region of Petit's triangle, after passing through the lumbar fascia near the quadratus lumborum, and may result from strains, wounds, abscesses, or appear spontaneously, especially in people of advanced age. It is easily reduced and retained by an appropriate belt.

Case of congenital lumbar hernia first noted at the age of 3½ years. The hernia was about the size of a

goose-egg and bulged on coughing or exertion. Petit's triangle was greatly enlarged. The hernial contents consisted of colon and appendix. There was no recurrence eight months after **operation**. Dowd (*Annals of Surg.*, Feb., 1907).

**Hernia into the Foramen of Winslow.**—This variety, though very rare, is of special importance, because it frequently gives rise to intestinal obstruction. It cannot be recognized without abdominal section, but treatment of the intestinal obstruction by

**Perineal Hernia.**—In this form the protrusion occurs between the fibers of the levator ani in front of the rectum; it descends behind the bladder in men, and the vagina in women. It occurs oftener in the latter than in the former and often penetrates the labium majus, forming the *labial*, or *pudendal*, hernia. A true labial hernia also occurs, the sac descending between the ramus of the ischium and the vagina into the posterior portion of the labium.



Labial hernia.

**enemata** is sometimes successful in bringing about the reduction by causing distention of the gut and traction upon the engaged loop.

**Ischiatic Hernia.**—This term is applied to protrusions taking place through the lesser sciatic notch, those through the greater being called *gluteal*. It may occur on either side, and may be either congenital or acquired. It has been seen more often in females. Its contents may be bowel, ovary, or a diverticulum of the bladder.

Incarceration of a portion of bowel along with an ovary has been observed in 3 cases. Ischiatic hernia is extremely rare (Garré).

It may be mistaken for Bartholinian abscess and labial cyst, but the inflammatory manifestations of the former and the absence of gurgling in the latter generally render a diagnosis easy.

Winckel, who found 6 cases in 5600 patients examined by him, recommends a **radical operation through the perineal tissues**.

The vagina sometimes becomes a hernial canal. Tendency to this is increased by traumatism, congenital defects, increased intra-abdominal pressure, a displaced uterus, and a vertical vagina. Incipient hernia should be treated by rest, lessening the intra-abdominal pressure, reducing fat, curing cough, the knee-chest position,

tampons, pessaries, etc. If the hernia is extensive, the pelvic floor should be repaired, the cystocele reduced, the vagina made less vertical, and the uterus properly treated. The levator ani muscle should be reunited. C. W. Barrett (*Amer. Jour. of Obstet.*, April, 1909).

Case in which a perineal hernia had apparently arisen from an abnormally deep vesicouterine pouch, passing down between the urethra and vagina. Thence the sac went forward through the posterior wall of the urethra and was extruded through the meatus. Atkinson (*Brit. Med. Jour.*, March 4, 1911).

**Obturator Hernia.**—This is a rare variety of hernia, which protrudes through the obturator foramen between the obturator externus and pectineus muscles, pushing before it the obturator fascia. The femoral artery and vein pass externally and in front of it, the adductor longus forming the opposite wall. The obturator artery and vein may lie to the inner or outer side of the hernia, especially near the neck,—anatomical features which should be borne in mind when operative procedures are to be resorted to. It is seldom recognized and may be mistaken for femoral hernia.

Its situation causes it to manifest itself in the majority of cases as an indefinite bulging or fullness of the tissues of the region, and careful palpation sometimes causes gurgling. It is usually met with in spare women past middle age and subsequent to the menopause. Men less frequently suffer from this variety of hernia. It is rarely distinguished before strangulation occurs. Pain down the leg along the obturator nerve is a distinguishing feature, in addition to the usual signs of strangulated femoral hernia.

**Taxis** is sometimes successful, especially if the thigh is flexed, adducted, and rotated inward. The muscles and tissues around the hernia are thus relaxed. If this fails, **herniotomy** should be performed, the nature of the vascular supply and the fact that the constriction is at the neck of the sac—which should be incised by cutting downward—being borne in mind.

Obturator hernia is oftenest met with in women who have been losing fat. The average age is about 60. A globular swelling, which may give an impulse on coughing, may be present under the pectineus. It is less mobile than a femoral hernia, has no palpable neck, and occupies a position rather more internal. The thigh may be flexed to relax the pectineus, while attempts at extension cause severe pain; adduction is resisted, tending to squeeze the hernia against the obturator externus. As symptoms of pressure on the obturator nerve there may be shooting or fixed pain referred to the inner side of the knee, or even toward the foot; flexion of the hip; weakness or spasm of the adductors, and impaired sensation in the terminal cutaneous branches of the nerve. H. W. Marshall recorded a case of associated pain in the knee and penis. Vaginal examination, which allows of palpation of the pelvic aspect of the obturator foramen, may assist in diagnosis. The mortality is high.

In **operating**, there are 3 methods of approach: Abdominal, femoral and combined. Opinion has come round in favor of the abdominal route. Powerful illumination and the Trendelenburg position are of great aid. The canal is easily closed by a purse-string or mattress sutures. To prevent recurrence, Short resected a piece of rib cartilage and inserted it into the canal, drawing the peritoneum over it by a purse-string suture. A lateral incision with the herniotomy knife should be avoided on account of the vessels. If the sac contained firmly

adherent intestine or omentum, it might be necessary to combine laparotomy with exploration from the thigh. A case of strangulated femoral hernia in a woman of 49, with operation and recovery, is reported. W. Tyson (Lancet, July 4, 1925).

**Retroperitoneal Hernia.**—Various forms of retroperitoneal hernia producing symptoms have in late years been reported, including *hernia of the left paraduodenal fossa*, *hernia of the right paraduodenal (mesentericoparietal) fossa*, *retrocolic hernia*, *hernia into the foramen of Winslow*, *intersigmoid hernia* (typically between the layers of the sigmoid mesocolon), *hernia through the transverse mesocolon* and *hernia into the broad ligament*. According to A. Rendle Short (Brit. Jour. of Surg., Jan., 1925), who made a combined study of these several types, an important part is played in the production of the sac, in most of the varieties of internal hernia, by vascular bands, which offer resistance along a particular line, beneath which the peritoneum gets pushed in. Thus, in the right and left paraduodenal hernias the superior mesentery artery and the inferior mesenteric vein, respectively, act in this way. Clinical symptoms, if present, may be of 1 of 3 types: Acute strangulation, recurrent subacute strangulation, or palpable tumor formation. Lower and Higgins (Ann. of Surg., Oct., 1925) pointed out that in the chronic cases the symptoms complained of are quite unlike the ordinary symptoms of intestinal disorder, and consist commonly of distention, nausea, belching, vomiting and constipation. The patient's general condition may long remain unimpaired. In acute cases the symptoms point to intestinal obstruction. The X-ray is of little aid, and the condition is usually identified only at operation or autopsy.

The treatment consists of **operation**. As noted by Short, surgical correction may be either easy, difficult or impossible. If the bowel is gangrenous, **resection** should be done; several patients have recovered as a result of this proceeding. Usually the patient is too ill to permit of an attempt at closure of the mouth of the sac; in favorable cases such closure should be carried out, with due regard for the vessels often

encountered in the neck of the sac. When reduction is impossible, it is generally feasible to cut the neck of the sac in an avascular region.

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**HERPES ZOSTER AND HERPES.**—These two disorders,—both the facial and genital varieties,—while not clinically identical, are closely related, according to Schamberg. The histology of the cutaneous lesions and the observed changes in the nerve structures examined appear in all to be practically the same. It is highly probable that the vast majority of all cases of herpes of the various types are the result of the action of a toxin. This proposition necessarily assumes the infectious origin of herpes. The frequency of herpes simplex in certain infectious diseases and its rarity in others is evidence that the toxin must possess certain peculiar qualities in order to exercise a selective affinity for sensory nerve structures. The toxins producing herpes simplex and herpes zoster are, in all probability, not the result of the action of any specific micro-organism. This is certainly true of the former, and by analogy may be assumed to be true of the latter, disease.

### HERPES ZOSTER (SHINGLES; ZONA).

**DEFINITION.**—Herpes zoster is an acute inflammatory disease of the skin, appearing over definite nerve areas, preceded by prodromata, accompanied by more or less severe pain, with usually a unilateral eruption, characterized by the occurrence of groups of firm, tense, globoid vesicles rising from an edematous base, sometimes followed by ulceration and scarring.

**SYMPTOMS.**—The outbreak of the eruption may or may not be preceded by malaise, fever, and pain. Children are more prone to suffer from malaise. Adults frequently have an initial rigor of no great severity with shivering. The temperature then generally rises, if any variation, to about 100.5° F. (38° C.) in adults and in children to perhaps 102° F. (38.9° C.). Malaise may disappear with decline of temperature as the rash erupts. The feverishness may last from three to five days. Pain is a particular characteristic of the disease, although it is not invariably present, especially in children. It is characterized variously, as dull, heavy, boring, burning, shooting, and sharply lancinating. It usually precedes the eruption; in fact, has been known to occur weeks before, but it also has been known to follow after the lesions have appeared. There may be hyperalgesia first in the area over which the cutaneous manifestation is about to come; or pain alone may be the first indication of the eruptive site. The duration of the pain is variable; it may disappear with the rash, but it is more characteristic to continue afterward, in extreme instances for months, and in elderly people even for years. In children it is ordinarily mild, while in the aged it is apt to be very severe. The pain is frequently worse at night, often causing marked insomnia. The pain in character is severe and steady rather than paroxysmal, and the course is from the posterior root of the skin terminus. Accompanying the pain there is likely to be anorexia, nausea, and in some instances vomiting. The time of the eruption is variable. It may start a few hours

after the onset of the disease, be delayed until the disappearance of the acute symptoms, or it may appear on the third or fourth day. Again, the rash may be fully presented at the end of two or three days after the appearance of the first spots, or continue to come out for a week or so. The vesicles commence to heal a few days after their appearance, but may continue for five or six weeks; if ulcerations are deep, scars mark their original site.

Head prefers to divide herpes zoster into two types, viz.,—*symptomatic zoster* and *spontaneous* or *acute specific zoster*. If the zoster is dependent on some pre-existing disease it may be considered *symptomatic*. It is known to have accompanied myelitis, spinal caries, tabes dorsalis, dementia paralytica, tumors of the cord, and even traumata.

[Under this heading the following case is worthy of citation ("Motor Complications of Herpes Zoster," by Albion Walter Hewlett, Cal. State Jour. of Med., vol. iv, 1906): A young man diving in shallow water struck his head with considerable force. He did not become immediately unconscious, but was unable to move arms or legs. In this condition he sank, became unconscious, and was rescued after being in the water about five minutes. Upon regaining consciousness, twenty minutes later, found arms and legs completely paralyzed. In thirty minutes power began to return to arms; next day arms were very weak. On each arm between elbow and shoulder was an area in which pain and heat senses were lost, tactile sensation remaining unimpaired. Three days later a bilateral cervical zoster appeared, involving the skin distribution of the third and fourth cervical segments. This healed rapidly with fully restored power. Nature of accident, sudden paralysis, dissociated loss of cutaneous sensation, favorable outcome, all form a diagnosis of hemorrhage into the cervical

cord. The zoster was of the symptomatic type. ROSE HIRSCHLER.]

**Acute specific or spontaneous zoster** appears to be characterized by those symptoms indicative of an acute infection. There is a prodromal period consisting of malaise, fever, and more or less pain. The sudden appearance of eruption; the limited course; the periodicity and epidemicity of the attack, are all indicative of an infection. The pathological



Herpes zoster, with facial paralysis. (Ebstein.)

findings, combined with symptomatology, make this type a disease *sui generis*.

The rash is characterized at first by a reddened or bluish-red patch of the size of a half-dollar silver piece or larger.

This area rises to the height of two or three lines, is sharply defined, and is exceedingly tender to the touch. So painful is it that often the friction of the clothing can scarcely be borne. The discoloration deepens and there is a sensation of heat or burning in the patches. In a very short time the vesicles appear.

The vesicles in herpes zoster when

fully formed are unlike those seen in any other disease of the skin. They rise from the surface of the edematous patch freely and distinctly, often having the appearance of being stuck on instead of forming an integral part of the tissues. They are tense, clear, and glistening, are oval or circular in outline, are always in groups, and the roof-wall in each is so firm that they do not ordinarily rupture unless subjected to mechanical violence.

At the outset the vesicles are filled with clear, translucent serum. This, in the course of a few days, grows cloudy in color and later becomes purulent. Hemorrhage sometimes discolors the contents of the lesions. The number of vesicles in each group varies from three or four to one or even two dozen. They are usually from that of a split pea to that of a coffee bean in size, but occasionally when very numerous are not larger than a mustard seed. When small the lesions are much more likely to break down. In most cases from three to a half-dozen groups may be found, but this number may be less or it may be greatly increased. The clusters are generally found following the course of a certain cutaneous nerve; but because of the overlapping of the filaments from different trunks, it is frequently difficult to determine the particular branch which is affected. The distribution is nearly always unilateral, but where the disease is severe the limits of demarcation are not sharply drawn at the median line, and the disorder may trespass upon it to a marked extent. This is due to the extension of nerve-filaments from one side of the body to the other.

Head says that the whole distribution of posterior nerve-roots is rarely if ever occupied with vesicles, and the whole distribution can only be obtained by including the border of the profound erythema.

A bilateral herpes zoster is generally conceded to be very rare, when no coexisting central nervous disease is present. In no case of spontaneous zoster has the bilateral eruption been at exactly the same level.

[A case of bilateral zoster is reported coincident with Hodgkin's disease. The eruption was attributed to the ingestion of arsenic (Clinical Studies, Edinb., vii, 351, 1909).]

The pain is more decided when the head is attacked than in the regions of the trunk or limbs. In rare instances complete anesthesia of the part follows or anesthesia dolorosa may supervene. Motor as well as sensory disturbances exhibited in local paralyses may occur.

Zoster infection involving the geniculate ganglion may induce clinical pictures ranging from the complete geniculate syndrome to almost pure facial paralysis. The spinal fluid generally shows lymphocytosis and high albumin and sugar in zoster. This proved of diagnostic service in 1 case. Worms and de Lavergne (Paris méd., June 10, 1922).

Oculomotor paralysis in ophthalmic zoster is not rare. After persisting weeks or months, it always disappears. Rosnoblet (Jour. de méd. de Lyon, Mar. 20, 1925).

Loss of hair and teeth and atrophy of the muscles have been noticed (Strübing).

Resolution takes place by absorption of the vesicular contents or a crust forms which desiccates and is then exfoliated.

The disease, fortunately, is usually benign, and seldom leaves any tell-

tale symptoms other than cutaneous scars. Second attacks of herpes zoster are rare, but when such occur, the earlier scarring is a proof positive of the first attack.

Indelible scars are occasionally left at the sites of the vesicles. They have a punched-out appearance, as if a nailhead had been driven sharply into the skin and had left its impress upon it, or they may be keloidal. These



Herpes zoster, with facial paralysis. (Ebstein.)

scars should never be mistaken for the relics of syphilis. The disease when attacking the region of the eye is apt to be unusually severe, and death has been known to follow. The eyesight is frequently endangered.

In virulent types of zoster hemorrhage into the vesicles may take place, giving them a bluish or blackish appearance (zoster hæmorrhagicus). An abortive form of zoster, in which the pain appeared in typical manifestation, but without the development of vesicles, has been noticed.

Coalescence of the vesicles often takes place. Where the blebs are



opened, dirty, grayish ulcers are apt to form. These ulcers are decidedly rebellious to treatment and invariably leave scars. Virulent gangrene may take place which may last for months, particularly in the insane. All of the groups do not usually appear at the same time, but come out one after the other at intervals during the first week or ten days. They enlarge somewhat, but seldom unite.

With the exception of inflammation and destruction of the eyeball in part or whole, it is interesting to note that no internal organ of the body has been found to be affected. Cases of zoster coincidental with pneumonia, or other organic disease, have been found over nerve-areas not particularly related to the affected organ.

**Regional Zoster.**—Herpes zoster may attack any part of the body, but it apparently exhibits a preference for certain sites, and to its appearance in these localities certain names indicative of the region affected are given. Thus we have zoster capillitii, *z. frontalis*, etc. When the disease invades two adjoining regions, more precise terms, such as zoster cervicobrachialis, *z. intercostohumeralis*, and so on, are used. The general features of each are the same, but, owing to anatomical differences, some characteristics need special description.

Zoster is not infrequently found attacking the various regions of the head. In the scalp (*z. capillitii*) the lesions are apt to be the seat of severe burning sensations, the occipital region being most often the part affected. Over the forehead (*z. frontalis*) disfiguring scars are likely to result. The branch of the supra-orbital nerve that passes upward is

here the one that is usually involved. The ear (*z. auricularis*) is sometimes attacked; and the cheeks, side of the nose, and chin are not unusual sites.

Ramsey Hunt has cited cases of herpes situated over auricle and within the meatus, which form is frequently associated with paralysis of the facial nerve. This writer claims that the geniculate ganglion supports the inflammatory lesion, a homologue of the posterior root ganglion. The disease may appear in the mouth-cavity (*z. buccalis*), upon the inner wall of the cheek, and the gums. Zoster exhibits its greatest severity when the eye (*z. ophthalmicus*) is attacked. The first branch of the fifth nerve is then affected. The nasal filament of the same nerve is often implicated and the eruption extends downward upon the nose and cheek. Sir J. Hutchinson says that the appearance of a nasal lesion should make one watchful for corneal ulcerations. The pain is severe. The conjunctiva is reddened and swollen, the cornea is inflamed, and iritis may follow, with marked disturbance of vision and edema of the neighboring parts. In its severer forms disintegration of the eyeball with loss of sight occurs and a resulting meningitis may lead to a fatal issue. Sympathetic involvement of the other eye may take place.

While we must regard zoster of this region as a grave affection liable always to destroy the eyesight and endanger life, yet instances are on record in which the attack, though serious, resulted most favorably. Head has never observed changes in the retina or optic nerve even in the most severe cases. Bowman has never known blindness to follow an attack.

Sattler wrote of rare instances of paralysis of ocular muscles and of ptosis, in some of which cases the herpes was not of the true spontaneous type, but was secondary to some growth or disease about the base of the skull.

Head witnessed several cases of zoster involving the third division of the fifth nerve—very rare.

Zoster is more frequently encountered on the surface of the thorax (z. pectoralis) and the neighboring abdominal (z. abdominalis) parts than elsewhere on the body. The right side is more often affected than the left. In the thoracic region the intercostal nerves are attacked. The pain is marked and when occurring before the eruption appears is apt to be mistaken for pleurisy. The presence of fever is needed to establish the latter affection.

In herpes zoster of the thorax considerable interference with breathing is liable to be experienced, owing to the pain occasioned by movements of the chest-wall. Duhring noted that the pain here may simulate the distress occasioned in angina pectoris. Because of the peculiar distribution of the diseased areas in these parts in the form of a belt or girdle have arisen the common designations of zoster as *zona* or *cingulum*. It is not unusual for the disease to be preceded in this situation for some time before its eruption by its characteristic pain. The nerves affected in abdominal zoster come from the dorsal and lumbar portions of the cord.

In 2 cases of spontaneous subarachnoid hemorrhage an herpetic eruption of a distribution corresponding to the nerve-roots was seen.

In 1 patient, vesicles developed on the upper thorax and over the deltoid on

the left side in the skin area supplied from the 4th and 5th cervical sensory roots.

In the other patient, the eruption developed on the 3d day of the illness on the right side of the chest in the lower portion of the 4th cervical nerve distribution. W. J. Adie (Lancet, Jan. 12, 1926).

Herpes zoster brachialis involves the shoulder and upper arm to the elbow. It may extend down the forearm, and even as far as the fingertips, attacking the palmar surface of the hand; but this is rare. The flexor surface of the arm is more often affected than is the extensor.

In zoster femoralis the disease spreads over the buttock, thigh, and down the leg. It usually does not go below the knee, and the feet are as seldom attacked as are the hands.

[In a case of generalized zoster, in an elderly man seen by Schamberg, the patient had a severe eruption involving the left posterior chest in the distribution of the third dorsal nerve, anteriorly the left pectoral region, and also inside of the left arm and hand. The vesicles were large and some hemorrhagic. There were also scattered vesicles and small, ill-defined papules on the right chest, both sides of the abdomen, the back, and the legs. The lesions numbered about 500].

**Zoster Atypicus Gangrænosus et Hystericus.**—Kaposi noted a peculiar form of recurring herpes to which he gave this name. Three of the subjects were women and one was a man. In all, distinct symptoms of hysteria were present. In each case the eruption consisted of vesicles and papules gathered in groups. A central crust formed in each vesicle, and about it there developed a number of tiny pustules. A number of the lesions coalesced, and gangrene of the part followed. After separation of the slough and healing by granulation

had occurred, keloid formed in many of the cicatrices. The period of development lasted for about eight days, when subsidence began to be evident. Both sides of the body were affected and in all but one case a number of recurrences took place.

**DIAGNOSIS.**—The recognition of herpes zoster does not usually present any great difficulty. The severity and peculiar character of the pain, the grouping of the large, firm vesicles upon an erythematous base, the lesions running their course without rupturing, and the common limitation of the trouble to one side of the body and over the course of some cutaneous nerve are the distinctive features that differentiate the disease.

At times *herpes simplex* assumes some of the severer features of zoster, or the zoster may be so mild that its manifestations partake of the benign nature of the simpler disease, in either of which cases some difficulty may be experienced in determining the true nature of the disorder.

*Erysipelas* usually begins with a marked rise in temperature. The affected area, although abruptly outlined, increases by peripheral extension, is edematous, and may or may not be covered with vesicles or bullæ which are not grouped. The color is an intense peculiar bluish hue, while zoster is a rosy pink.

With *eczema* zoster need never be confounded. The vesicles are wholly unlike. Those of eczema are small, thickly and irregularly scattered over the surface, and they rupture readily, while a continuous flow of serum follows their dissolution.

Zoster has been noted coincidental with *chicken-pox*. The pain, grouping of vesicles, and unilateral distri-

bution should differentiate zoster. Although there may be some scattered, isolated vesicles over the body, these would cover some nerve-area; there would be a group of vesicles on an erythematous base not seen in vari-cella. If coincidental, the zoster rash would not be influenced by the chicken-pox.

Zoster is not uncommonly seen in *psoriasis*. The rashes are so entirely different a tyro could differentiate the two. It is probable that arsenic, so often given for psoriasis, is the cause of the zoster.

**ETIOLOGY.**—According to Stel-wagon, herpes zoster constitutes 1 to 1.5 per cent. of all skin diseases.

Many causes have been suggested as factors in the production of the disease. Age nor sex seems to have any particular influence, neither does occupation or nationality. It occurs in either sex, but there may be a preponderance in the male. The greatest frequency is between the ages of 8 and 20 years. It is not uncommon over 40; Lomer and Knowles each reports cases in infants of 4 days.

In general, there is thought to be some seasonal influence, with the greatest frequency in the spring, late fall, and winter. Atmospheric conditions appear to modify this for unknown causes, although Schamberg's experience does not indicate any special tendency. He cites 156 cases observed at the Polyclinic Hospital as follows:—

Winter (Jan., Feb., March) . . . .	40 cases.
Spring (April, May, June) . . . .	35 cases.
Summer (July, Aug., Sept.) . . . .	42 cases.
Fall (Oct., Nov., Dec.) . . . . .	39 cases.

Cases have occurred following sudden change of surface temperature.

of the body; after traumata, as the prick of a thorn (Janin), abscess incision, gunshot wounds; after the administration of some drugs, particularly arsenic—a marked example of which is shown in the noted epidemic in England, due to beer which was found to contain arsenic. Mental exhaustion, overwork, and excessive physical exertion are said to precipitate attacks.

Schamberg believes that when the disease is not traumatic it is probably an infective process due to the action of toxins developed from various sources. It has followed in the wake of pneumonia, influenza, measles, malaria, and epidemic cerebrospinal meningitis. Head considers it an acute posterior poliomyelitis.

The zoster virus comes to the skin through the blood-stream, thereupon inducing an inflammation of the veins and at the same time a necrobiosis of the epithelial cells. This view is not to be taken as precluding a nervous influence. According to Vörner, 2 factors are involved, *viz.*, a nervous lesion, generally traumatic, and some toxic material. In the writer's view, there is a hypersensitiveness of the area of skin supplied by the nerve which permits an amount of toxic substance ordinarily too small to cause disturbance to bring about the zoster changes. E. Lehner (*Derm. Zeit.*, Feb., 1925).

Thirty-five cases of zoster in adults were observed by the writer in 1 small community in a few weeks' time. Tichy (*Casop. lek. cesk.*, Nov. 21, 1925).

Epidemics have been recorded, and there are undoubted cases of infection.

Herpes zoster in a household is often followed by a case of chicken-pox. Chicken-pox may be followed by herpes zoster in the same house. Herpes zoster, in addition to the ordinary lesions, may show an eruption

similar to chicken-pox. R. C. Low (*Brit. Med. Jour.*, July 25, 1919).

Children up to 5 years can be inoculated with zoster, and some develop a generalized eruption like chicken-pox after 9 to 15 days' incubation. Child contacts with them developed chicken-pox. Serum from zoster convalescents protected against chicken-pox. B. Lipschutz and Kundratitz (*Wien. klin. Woch.*, May 7, 1925).

**PATHOLOGY.** — Barendsprung demonstrated that the disease was primarily one of the ganglionic system, and this has been confirmed by numerous other investigators. Wyss examined a case dead of zoster facialis, and found the ganglion of Gasser enlarged, soft, and deeply injected. The nerve between the brain and ganglion was surrounded by extravasated blood. It was healthy at its origin. The peripheral filaments were infiltrated with soft tissue.

Danielsen reported the intercostal nerve reddened and thickened and the neurilemma markedly infiltrated in a case of zoster of the trunk.

Later studies have confirmed the statements of these older observers.

Head and Campbell undertook the study of zoster largely to "define the central representation of the affected area of the skin." The skin terminus was outlined by the site of the eruption. The central station was determined through Marchi's osmic acid method, and the findings disclosed were small hemorrhages into the posterior ganglion in the most acute cases; these were surrounded by leucocytic infiltration. The ganglion cells were destroyed in part, and in the older cases parts of the ganglion were much sclerosed. The secondary changes disclosed some degeneration of the peripheral afferent nerves; also,

degeneration of the posterior roots and the same process could be traced by the same method in some instances up the posterior column of the cord. The studies were made on 21 necropsies, varying from a few days to one and a half years after the eruption. In the case of zoster following blows and injuries to the skin, only the terminations of the nerves appear to be affected.

A vaccine administered for chorea was followed by herpes zoster. Greeley (*Jour. A. M. A.*, Dec. 2, 1916).

Association of zoster with alveolar and tonsillar disease suggests that zoster arises from focal infection. Lain (*Jour. Cutan. Dis.*, Aug., 1917).

The skin lesions of zoster have received much attention. Biesiadecki and Haight were the first who made a careful study of the vesicle. They found that it began in the deeper layers of the rete and that the exudation forcing its way upward separated the rete-cells, forming elongated bands or threads. After reaching the horny layer the fluid—no longer able to make its way between the cells—lifted the epidermal layer bodily, thus forming the roof-wall.

Robinson's investigations led him to the discovery of a perineuritis of the cutaneous nerves exhibiting a small-celled infiltration of the neurilemma.

Fine nerve twigs in the deep layer of corium show, according to Head, definite swelling of the neurilemma; the myelinated sheath is degenerated; the axis-cylinders show moniliform swellings. Large branches show marked degenerative changes (Marchi's method) ten days after the onset of the eruption.

Unna found that the vesicles in herpes zoster had a structure dis-

tinctively their own, due to a peculiar form of epithelial degeneration to which he applied the term "ballooning." In the process of colliquation that here takes place, the cells increase greatly in size, becoming, in many instances, hollow spheres, and in others with one side drawn out, suggestive of a balloon. Other unique and various forms are assumed. The protoplasmic contents are converted into a fibrinous, opaque mass, the nucleus is divided into a number of daughter-bodies that do not wholly lose their nuclear character, and the prickles are lost, thus severing the union of the cells the one with the other. In this disorganized condition the cells separate and accumulate in the hollow of the vesicle.

From the roof-wall of the lesion are seen hanging a number of compressed, cord-like, epithelial cells, forming a species of partition, thus dividing the cavity apparently into a series of compartments. But because of the indifferent connection possible in the cells undergoing this form of degeneration there is no real division of the vesicle. The vesicle contents, in addition to the degenerated epithelia and giant cells, consists of coagulated fibrin. Into the base of the vesicle can usually be seen projecting the denuded summits of the papillæ. The vesicle is situated well within the epithelial tissues.

When the acme of vesicle formation is reached, marked emigration of leucocytes from the neighboring vessels into the papillary body and the vesicle takes place. It seems, however, never sufficient to fill the cavity of the blister, crusting and desiccation occurring before this condition is reached.

What appears peculiarly striking is the relatively unimportant changes that take place in the epidermis around and beneath the vesicles. The blood-vessels and lymph-spaces are dilated for but a few lines only. The sweat-glands are not affected. The hair follicles share in the process, inasmuch as the prickle-cell layer dips downward toward their base. The cutis is involved in a slight degree only and that mainly by the infiltration of a few leucocytes.

Pfeiffer was the first to call attention to some peculiar bodies in the vesicles of herpes zoster.

**PROGNOSIS.**—Herpes zoster runs its course usually in from three to six weeks. Abortive types may end in ten days or less, while the severer forms may be much prolonged. The disease is rarely fatal, save when the ophthalmic region is attacked. A lethal issue is then possible, and the eye may be sacrificed even if life be spared. Scarring is a not infrequent sequel of zoster if the vesicles be broken. The cicatrices are gathered in clusters typical of the grouping of the disease, and each has an angular outline with precipitous edges that gives to it a distinct and unmistakable individuality. Long continuance of the neuralgia may vex and weaken the nervous system until the subject becomes a complete physical and mental wreck. Such cases are, however, exceptional. Its increased severity is, no doubt, due to the greater involvement of nerve ganglia, but the gravity that once was supposed to attach to the trouble has been disproved.

Herpes zoster recurs so seldom that one attack is believed to render the patient immune.

**TREATMENT.**—Herpes zoster is a self-limited disease, rarely endangering life, and seldom recurring. Its treatment is, therefore, simple. The most urgent indication with which we have to contend is relief of the pain. This is sometimes nearly unbearable. The character of the distress is likened often by the patient to that of a red-hot iron drilling into the flesh. Sleep then is impossible, and the restlessness is extreme.

The affected patient should be put to bed and absolute quiet enjoined. **Freedom from worry and care**, coupled with **complete physical relaxation**, is essential to the best results to be obtained from treatment. The bowels should be moved freely. For this purpose a mild dose of **calomel** given at bedtime, followed by a brisk **saline cathartic** in the morning, answers well. To keep the bowels open, a glass of warm **Hunyadi water**, or a **Seidlitz powder**, may be given each day before breakfast.

The **diet** should be light and easily digestible. Milk freely if the patient can tolerate it; broths, soups, soft-boiled eggs, oysters in season, fish, and chicken should constitute the list from which the articles of food for the patient's need may be selected. These patients often have very good appetites, and care should be exercised in not allowing overindulgence, such a course usually being followed by marked aggravation of the pain.

Internal medication has not as yet shown itself capable of shortening the course of the disease. But there are a number of drugs that markedly affect the pain and make the patient's condition bearable. Chief among these is **zinc phosphide**. This may be given in doses of  $\frac{1}{16}$  to  $\frac{1}{8}$  grain (0.01

to 0.02 Gm.) in tablet form every two or three hours until the pain is under control, when the dose may be reduced. It is sometimes more effectual when combined with the extract of **nux vomica**,  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.008 to 0.016 Gm.) of the latter drug being used. **Sodium salicylate** and **salicin** in 10-grain (0.6 Gm.) doses every four hours, especially if there be any rheumatic taint, are often productive of much good. **Antipyrin**, **phenacetin**, and other drugs of the series relieve the pain, and it is thought to have even shortened the course of the disease (Jennings). **Arsenic** is often used, but we should not forget that it is capable of producing the affection, and therefore likely to aggravate, instead of benefiting the disorder. When employed it should be used in full doses,  $\frac{1}{20}$  grain (0.003 Gm.) of **arsenous acid** in tablet form, or combined in a capsule with a small amount of **iron**, being given four times a day. Or, 3 to 5 minims (0.18 to 0.3 c.c.) of **Fowler's solution** in water after taking food may be used.

**Quinine** in full doses is serviceable when malarial poisoning is the basis of the trouble.

**Camphor** in small doses, often repeated, has been found to give the patient comfort.

If there be much nervousness, the **bromides of sodium and potassium** may be needed, but it is best to do without these drugs if possible. Tincture of **aconite** in drop doses at intervals of two hours has proved serviceable. **Sodium hyposulphite** in 5-grain (0.3 Gm.) doses every three hours does good.

If we cannot control the pain by drugs given by the mouth we may resort to hypodermic injections. Ten

minims (0.6 c.c.) of **chloroform** may be sufficient to check the pain. **Morphine sulphate** given subcutaneously in from  $\frac{1}{4}$ - to  $\frac{1}{2}$ - grain (0.016 to 0.032 Gm.) doses will always control it. It is well to combine this drug with **atropine sulphate**,  $\frac{1}{100}$  to  $\frac{1}{60}$  grain (0.00065 to 0.001 Gm.). **Adrenalin** and **pituitary extract** have been found useful.

**Adrenalin** relieves the pain almost at once in over  $\frac{1}{2}$  the cases if given in adequate dosage. As a general rule, it should be given subcutaneously in doses of about  $\frac{1}{2}$  c.c. (8 minims) at 5-minute intervals. When the tremor appears, the pain usually disappears, but it generally returns in from 2 to 24 hours. The amount necessary to give relief for tremor varies from 1 minim up to several cubic centimeters, according to the individual; in fact, it varies in the same individual at different times almost to this extent. It can be repeated and continued indefinitely without harm. The drug does not seem to have any effect on the vesicular lesions. W. W. Duke (Jour. Amer. Med. Assoc., Dec. 13, 1924).

Eighteen cases of herpes zoster treated with **pituitary extract** in the course of 8 years. The author used for each alternate patient hypodermic injections of 1 c.c. or less of **pituirrin**, while the other patients received the usual treatment only. The results were strikingly different. The patients receiving pituirrin were relieved of pain in a few hours and the eruption disappeared in a few days. In the others the disorder followed its usual course. Pituirrin was not employed in pregnancy or high blood-pressure, nor in aged patients. As some malaise was experienced, the patient was instructed to lie down for 15 or 20 minutes after the injection. Vendel (Ugeskr. f. Laeger, Mar. 29, 1923).

External treatment should not be neglected. The vesicles should be preserved intact if possible. Opening

them will not at all shorten nor mitigate the disease, and it nearly always results in the production of an obstinate ulcer that leaves an ugly scar. No picking or rubbing of the lesions should be permitted, and all sources of irritation—especially harsh woolen underclothing—should be removed. Dressings for protection from the air are useful.

One of the best applications that can be used is **alcohol**.

It should be used in full strength, 94 per cent., and at frequent intervals. Compresses of cotton or soft-linen stuff should be saturated with the alcohol and bound over the parts. To prevent evaporation, these should be covered with some impermeable material, such as oil-silk or gutta-percha. This gives prompt relief to the burning and local distress, and affords the patient much comfort.

Ointments and pastes can often be used to advantage. **Lassar's paste** (see HERPES SIMPLEX) is useful. When properly made it furnishes a good protective dressing. It should be thickly applied and then thoroughly dusted over with a simple powder, such as **talc** or **cornstarch**. Anodyne remedies—such as **opium**, **belladonna**, or **cocaine**—may be added to it if needed. It is capable of relieving the cutaneous symptoms, and under it the lesions dry up and heal without rupturing.

Simple ointments may relieve the itching and burning, but their softening influence upon the epidermis renders the rupture of the vesicle more probable.

**Lime-water**, **black-wash**, **carron-oil**, and **lead-water** washes may be found useful. They should be applied freely, the surface being kept constantly

moist with gauze saturated with the agent chosen. **Lotions of carbolic acid** and **camphor**,  $\frac{1}{4}$  to  $\frac{1}{2}$  dram (1 to 2 Gm.) of each to the ounce (30 c.c.) of alcohol, are valuable. The following substances in alcoholic or aqueous solution are often found useful: **Tannin**, 30 to 60 grains (2 to 4 Gm.) to the ounce; **menthol**, 5 to 15 grains (0.3 to 1 Gm.) to the ounce; **benzoin tincture**, 30 minims (1.8 c.c.) to the ounce; **resorcin**, 5 to 15 grains (0.3 to 1 Gm.) to the ounce. These should be applied freely to the affected parts and allowed to dry, after which a dusting-powder may be used with advantage.

Such a dusting-powder may be made of **zinc oxide**, **starch**, **boric acid**, **lycopodium**, or **talc**. **Anderson's dusting-powder**—which is compounded of camphor (1), zinc oxide (3), and starch (12)—is especially useful.

Where tenderness can be detected over the exit or in the course of a spinal nerve the **wet cup** may be tried. Not more than 1 ounce (30 c.c.) of blood should be abstracted. Or, a **blister** may be applied. For this purpose **cantharidal collodion** answers very well, and frequently gives marked relief.

The **constant current** has been very highly spoken of. From 5 to 10 zinc-carbon cells should be used. The negative pole is placed over the eruption and the positive grasped in the patient's hand or, better, passed up and down the spinal column. If used early enough this will abort, shorten, or at least greatly subdue the pains of the disorder. It is of great value in the subsequent lingering pains. In such cases the current should be used 2 or 3 times daily, 15 minutes at a time.



**Galvanism** is of considerable value. Other methods include **faradism**, **high frequency currents**, **X-rays**, **wet and dry cupping** over the affected ganglia, **cocaine salves** and **injections**, and freezing with **ethyl chloride spray**. The writer particularly recommends the spraying of **melted paraffin**, in particular **parresine**, with an atomizer on all of the skin lesions and covering with a generous layer of absorbent cotton, held in place by bandages. This treatment was used in 17 cases, all rendered more or less sleepless by the pain. It always gave almost immediate relief. Daily applications were made, the previous layer being each time gently removed, avoiding possible rupture of the vesicles. If the old layer is too adherent, it may be allowed to remain and a fresh coat sprayed over it. Howard Fox (Jour. Amer. Med. Assoc., Dec. 9, 1922).

### HERPES (Herpes Febrilis).

**DEFINITION.**—Herpes simplex is an acute, non-contagious, benign disease of the skin, usually dependent upon a neuritis of the nerves supplying the part, and characterized by an eruption of vesicles in groups upon an inflamed, edematous base.

Herpes simplex may attack any part of the body-surface, but the malady shows a decided preference for two localities. These parts are the facial and genital regions. Because of the usual distinct restrictions of the disease to one or the other of these sites, and the diversity in symptoms that is liable to be manifested, two varieties of the disorder have been distinguished, and to each has been given a separate title. They are called *herpes facialis* and *herpes genitalis*. While essentially the same in nature, the specific causes apt to produce them, the dissimilarity of their manifestations, and the various diseases with which they are likely to

be confounded make their individual description a matter of necessity.

Herpes simplex appears but rarely in other situations upon the body and still less likely is it to occur in a generalized form. When such does happen, the term "*herpes generalis*" is applicable.

Among 246 cases of malaria, 121 had herpes and 98 developed it after each attack. It recurred invariably at the same point, usually the lips, but 3 times on the ear, 5 times on the tongue, etc. Garin and Descos (Prog. méd., July 14, 1917).

**SYMPTOMS.**—Herpes facialis may occur upon any part of the face or forehead.

The vermilion borders of the lips—also of the nose, upper lip, cheeks, and auricles—are favorite sites for its appearance.

The mucous membranes of the mouth and throat are often implicated. So, too, the disorder may attack the cornea.

At the outset a slight tingling or burning is felt in the parts about to be attacked. Redness and swelling rapidly follow, and upon this edematous base a cluster of tiny vesicles soon appears.

Usually an areola surrounds the group of vesicles. The groups vary in number from one to a half-dozen or more, and in size from the surface of a split pea to a silver twenty-five-cent piece. They are round, oval, or irregular in outline, and may be closely set or widely separated. The vesicles are from pinhead to a kernel of wheat or larger in size and number three to a dozen or more in each group. They are fairly firm to the touch and do not readily rupture. Most authors describe a preceding papular stage. This is exceedingly

hard to demonstrate, and, if it does exist, is of very short duration. With care in the examination, fluid may be found in the lesions at the moment of their inception.

At the outset each vesicle is filled with clear, transparent serum. This gradually grows turbid, until by the end of the second or third day, if the lesion be not sooner ruptured, the liquid assumes a milky condition, and examination under the microscope shows an abundance of pus cells and degenerated epithelium. Where closely set the vesicles may coalesce, forming a flat-topped bleb.

Unless interfered with, the vesicles run their course in from four to ten days, the process then being completed by the formation of a crust, which desiccates and falls, leaving a brownish, pigmented spot. This pigmentation gradually disappears without forming a scar or other relic of the disease.

If the vesicle, as usually happens, is broken by picking, rubbing, or scratching, an excoriation results, which, if it does not become infected, is shortly covered with a crust, and the disease then runs its usual course and terminates in the ordinary way. Such crusts are dry and firmly attached. When the excoriations become infected with pus cocci or are treated with strong caustics, grave ulcers are apt to supervene and disfiguring scars remain.

Hemorrhage into the vesicle (black herpes) and gangrene sometimes complicate the process.

Subjective sensations are usually slight. The unsightliness of the disease causes the patient more distress than does the pain of the disorder. The tickling, burning, or prickling

sensations occurring at the outset may continue for a day or two and then subside, no further distress being experienced. Sometimes, though rarely, more or less itching is complained of, and even pain is occasionally felt.

Herpes of the mouth and throat (canker spots) presents a somewhat different appearance. Owing to the moist, warm condition of the parts the vesicles cannot develop as such. A round or oval patch, slightly elevated, and covered with a whitish, sodden exudate, is first formed. These spots may be situated upon the upper or under surface of the tongue, the border of the gums, the inner wall of the cheek, the palate, or the tonsil.

Herpes of the mouth, while not always severe, usually occasions considerable distress.

A condition that is known as "herpetic fever" is occasionally met with. The disease usually occurs in epidemics and is characterized by languor, vomiting, and chilly sensations, followed by a rigor and then a sudden attack of fever. The temperature may reach 104° F. (40° C.); the tongue is moist and heavily coated; the throat is sore, and the glands of the neck enlarged. Restlessness and delirium are exhibited at night. On the second day the vesicles appear and are usually confined to the face. Crocker speaks of defervescence being associated in some cases with the herpetic outbreak.

The disease runs its course in about four days, terminating in recovery.

The course of the disease and its occurrence in epidemics point to an infectious origin. Cases have been traced to sewer gas and faulty hygiene.

**DIAGNOSIS.**—Herpes facialis is to be distinguished from *eczema* by the larger size and greater stability of the vesicles, by their peculiar grouping, the insignificant sensations accompanying the disease, and the rapidity with which the disorder runs its course. There is no weeping, as in *eczema*, and no successive new formation of vesicles upon the same sites. The resemblance of herpes, when the lesions have broken and crusts have formed, to *impetigo* is sometimes marked. But in *impetigo* the crusts have been preceded by a single vesicle, bleb, or pustule. Instead of a group of vesicles, the patches of disease are not distributed in the line of any cutaneous nerve, but are scattered irregularly over the surface, and typical lesions can usually be found upon the hands and also upon the trunk. There is often a history of contagion. Care must be exercised in not confounding herpetic lesions of the mouth with the *mucous patches of syphilis*. Many patients, frightened by the knowledge of their exposure to syphilitic infection, point to their frequently recurring canker spots as indubitable proof that they possess the disease. More decisive evidence in the form of scars, alopecia, gummata, or the peculiar eruptions of syphilis must be searched for and found before confirmation of the subject's fears should be given. Veterans of syphilis are sometimes subject to herpetic troubles of the mouth that give rise to much mental distress on the part of the patient, but which are not in any wise related to the precedent lues.

Herpes simplex can be distinguished from *herpes zoster* by the bilateral distribution of its lesions, the

presence of fever, and the lack of nerve pain.

### HERPES FACIALIS (FEVER-BLISTERS).

**ETIOLOGY.**—Herpes facialis is a common, though not necessary, accompaniment of many fevers and of catarrhal disorders of the nose, throat, bronchial passages, and lungs. The popular designation "cold sore" is indicative of the frequency with which the complaint occurs in simple coryza. Typhoid and intermittent fevers frequently give rise to it. Herpes simplex is very apt to occur in pneumonia not only upon the face, but upon the genitals and at times in other localities upon the body. At one time it was believed to occur regularly at the crisis in all cases of sthenic pneumonia in which a favorable outcome was likely to occur. Such auspicious prognosis, however, can no longer be maintained.

Although herpes febrilis commonly affects areas where skin joins mucous membrane, cases are sometimes seen in which the eruption is situated on parts of the skin at some distance from mucous membrane, and most works on skin diseases mention the fact that recurrent febrile herpes may appear upon the cheeks, the neck, or the buttocks, often recurring again and again in the same spot. Crocker quotes a case of Barthélemy of an "old woman dying of pneumonia, in whom some patches on the chest, with very large vesicles, were referable to herpes febrilis rather than to zoster." The writer has been unable to find any reference to cases of febrile herpes attacking the fingers, and thinks that the following examples are of sufficient interest to be recorded.

**CASE 1.**—A boy who, until 5 years of age, was in the habit of sucking his thumb, had periodical attacks of

an eruption of a group of three or four pinhead-sized vesicles on the end of the thumb. These eruptions were at first put down to the irritation of sucking, but after a time it was found that they coincided with the onset of an ordinary cold, and that a similar eruption sometimes appeared on the forefinger, which was not sucked. Once or twice the eruption on the thumb and forefinger was associated with ordinary herpes febrilis of the lip.

CASE 2.—A boy aged 4 years, a photograph of whose finger is here reproduced, presented a group of herpetic vesicles on the dorsal surface of the second joint of the left index finger. He had been fretful and poorly for some days. There was a single vesicle at the junction of the mucous membrane of the lower lip with the skin. There was no history of previous attacks.

CASE 3.—A girl aged 8 years, suffering from acute apical pneumonia, presented a group of vesicles upon the dorsal surface of the index finger of the right hand. (H. G. Adamson).

Disturbances of the digestive tract, especially in children, are prone to produce herpes of the lips. Indigestion, gastritis, gastric ulcer, and enteritis in adults are frequently associated with this form of herpes. It is not unusual in malaria, but is said to be rare in relapsing fever. Herpes of the nose and lips often coexists with tonsillitis and bronchitis.

In some persons merely brushing the face or the lips with a feather will induce the disease. Many women are affected at each menstrual epoch with labial herpes. Toothache as well as dental instrumentation are known to produce the trouble.

Blows upon the head, exposure of the face to alternate hot and cold blasts, or the application of irritating medicaments are effective factors.

Experimentation has revealed that there is associated with herpes febrilis a filtrable virus capable of causing in the rabbit, not only a severe keratoconjunctivitis, but also encephalitis and death. According to some observers, herpes simplex, irrespective of its clinical variety, is a generalized, specific infectious disease with local cutaneous symptoms—the herpetic eruption—and at times, particularly in herpes progenitalis, nervous involvement. The investigations of Levaditi and Harvier, and of Doerr and Schnabel, led them to the con-



CASE 2.—Herpes febrilis. (Adamson.)  
(British Journal of Dermatology.)

clusion that there is a common virus in herpes febrilis and in lethargic encephalitis. Other investigations suggest that zoster and herpes simplex are produced by related viruses differing, perhaps, only in their virulence.

Experiments showing that herpes, whether idiopathic or complicating cerebrospinal fever, is an infectious disease capable of transmission by corneal or subdural inoculations in rabbits. The brain of an inoculated animal is infective to other animals. The cerebral lesions are manifested clinically by nervous symptoms such as stereotyped circus movements of the body, unusual positions of the head, profuse salivation, stiffness of the jaw, convulsions and paresis. Necropsy of the brain always reveals pathologic changes identical with those

found in lethargic encephalitis. According to Levaditi and Lipschütz, the same results are obtained with herpes complicating pneumonia and herpes zoster. Szymanowski and Zylberlast-Zand (Brain, May, 1923).

Lesions analogous to herpes zoster in man were produced by inoculating the tarred skin of guinea-pigs and rabbits with the virus of herpes simplex. Teague and Goodpasture (Jour. of Med. Research, Dec., 1923).

Unequivocal strains of herpes virus exist in man, which, in the rabbit, exhibit a degree of encephalitogenic power not exceeded, and perhaps rarely equalled, by any strain of the so-called encephalitis virus. Mild strains also exist, the action which tends to be restricted and local. Unless injected intracranially, these mild strains do not tend to produce virus encephalitis in the rabbit. Recovery from infection with the mild strain confers immunity to virulent strains of the herpes and allied viruses. The herpes virus can be excreted by the kidney of the rabbit and detected in the urine by rabbit inoculation. Flexner and Amoss (Jour. of Exp. Med., Feb. and Mar., 1925).

The writer has herpes simplex, recurring every 4 to 8 weeks. One year after marriage, his wife had herpes for the first time. The infection was successfully transmitted to rabbits, producing keratitis and encephalitis. P. Rezek (Med. Klin., Jan. 15, 1926).

In several patients the writer induced herpes febrilis by injections of vaccines, more particularly vaccines of meningococci and colon bacilli. In a majority of instances Loewenthal transmitted the herpes infection to rabbits. O. Naegeli (Schweiz. med. Woch., Jan. 16, 1926).

**PATHOLOGY.**—Unna found the process originated in the upper layer of the rete mucosum a coagulation necrosis. The cells affected were enlarged and the cell contents greatly changed. The nucleus had disappeared and the protoplasm could not

be stained. This was due to saturation of the cell with fibrinogenous substance from the fluid surrounding the cell-body. The cell retained its normal shape and the prickles remained intact. Beneath the zone of necrotic tissue a layer of flattened and thinned prickle cells was found that still retained its normal features and the cells their capacity for staining, thus indicating that the elevation of the whole epithelium was a secondary, and not a primary, occurrence. Deeper down in the rete were cells in a necrotic condition. In most of these the nucleus had disappeared, leaving only a cavity, while, in some, cell substance had been completely dissolved in the fluid of the blister. The heads of many papillæ projected into the cavity of the lesion and were entirely denuded of epithelium. It would appear, then, that the process consists of two distinct steps, the first consisting of a fibrinous inflammation of the upper prickle-cell layer, converting it into a nuclear, degenerated, necrotic mass, forming later the roof-wall of the vesicle. The second, the loosening of the epidermis as a whole, with the formation of a subepithelial blister, whose contents again undergo coagulation necrosis. The blood-vessels and lymph-spaces underneath and about the lesion were found markedly dilated, and distinct, though not extensive, migration of leucocytes was evident.

**PROGNOSIS.**—The disease is a benign disorder running its course, if not irritated, in from four to twelve days. No scarring is produced. Pigmentation follows the desiccation of the vesicles, but this soon disappears. The disease is exceedingly prone to

recur,—in many patients with almost periodical regularity.

**TREATMENT.**—The treatment of herpes of the face should be of the simplest kind. All irritation should be removed. No picking, scratching, or rubbing should be allowed. The smoker should be made to give up his pipe or cigar, and all forms of tobacco had best be interdicted.

Strong **acetic acid**, if applied at the outset before the vesicles have formed, will often cut short the attack or greatly lessen its severity. The action of the acid should be checked before whitening of the skin takes place. If the itching and burning are at all severe, lotions of dilute **lead-water** and **opium**, **zinc oxide** and **lime-water**, **elderflower-water**, **camphor-water**, or weak **ammonia-water** may be used freely. These should be followed by a simple dusting-powder, such as **starch**, **boric acid** and **talc** (1 to 8), **stearate of zinc**, or **lycopodium**. Painting the parts with **flexible colloidion** after the vesicles have fully formed makes an admirable dressing. Ointments, as a rule, are not well borne. The **Lassar paste** (**salicylic acid**, gr. v [0.3 Gm.]; **zinc oxide** and **talc**, of each, ʒij [8 Gm.]; **vaselin**, ʒiv [16 Gm.]) makes a good protective covering.

Internal medication for the relief of the disease while in its course is useless. As a prophylactic, according to Dühring, **arsenic** is of positive value, and will cure the tendency to the disorder. It should be given in full doses:  $\frac{1}{20}$  grain (0.003 Gm.) of **arsenous acid** four times a day, or **Fowler's solution**, 3 to 7 minims (0.18 to 0.42 c.c.), after meals. **Cold sponging** of the body each day, especially of the spinal region, followed by **vigorous**

**friction**, will help to control the tendency.

The treatment of recurrent herpes is uncertain of results. In the case of recurrent herpes appearing on the face of a young woman or a girl the use of caustic applications should be avoided; in fact, it would be best to leave the affection entirely alone. The same applies to groups of vesicles filled with serous fluid. The simplest applications are indicated, as a lotion consisting of a hot **decoction of chamomile flowers** (about 5 flower heads to 1 pint of water) applied cautiously by means of sterilized cotton. At night the following ointment is to be used:—

R *Ichthyol* ..... gr. xv (1 Gm.).  
*Zinc oxide* ..... ʒj (4 Gm.).  
*Simple cerate*,  
 freshly prepared, free  
 from water ... ʒix (36 Gm.).

M.

During the day a slight application of **casein ointment** may be made, which is afterward lightly dusted with **talcum**. Pautrier (*Le Bull. méd.*, March 19, 1910).

In 19 cases out of 20, sufferers from recurring herpes of the tongue are syphilitic. While mercurial treatment would, in consequence, seem to be indicated, it only aggravates the condition when it is actually attempted. Irritating substances, such as alcohol, spices, mustard, and especially tobacco, are likewise harmful and should be forbidden. A bland diet, consisting of milk, vegetables, cooked fruit, and thoroughly cooked white meats, should be ordered. As for local treatment, emollients alone are indicated in the inflammatory stage. A **decoction of althea**, used as a tepid local wash, and alkaline solutions, such as **Vichy water** or a 0.5 or 1 per cent. solution of **sodium bicarbonate**, are particularly useful. As the inflammatory process subsides, mild astringents, such as a 1 or 2 per cent. **decoction of strawberry root**, may be employed, while during the

intervals between attacks **gambir** is suitable. Where ulceration is present, the writer applies **camphonaphthol** in minute quantities or Vidal's formula:

**R** Powdered sodium  
borate ..... 5iiss (10 Gm.).  
*Cherry-laurel*  
water ..... 3vi¼ (25 Gm.).  
*Neutral glycerin* . 3iv (15 Gm.).

M. et ft. lotio.

If there is marked pain, a 2 or 3 per cent. solution of **cocaine hydrochloride** is painted over the lesions, particularly before meals. Plicque (Bull. méd., March 9, 1912).

In a case of recurrent generalized herpes simplex, the writer isolated a causative streptococcus, and cured the condition with an **autogenous vaccine**. Frank Cohen (Jour. Amer. Med. Assoc., May 20, 1916).

A woman aged 22 had had for 8 months a herpes of the palm of the hand recurring every 2 weeks. Each time there was a local feeling of heat and pain, followed in a few hours by erythema and the next day by vesicles, lasting 4 to 7 days and replaced by crusts. The writer practiced **autoserotherapy**, making 10 hypodermic injections of 2 c.c. (32 minims) of the patient's own serum at 3-day intervals. After these injections no further recurrence took place. Similar success was had in 2 other cases. Tzanck (Bull. Soc. franç. de derm. et syph., No. 10, 1921).

Six cases of recurrent herpes of the hands treated with the **ultra-violet rays**, with resulting cure to date for a year in 2 cases and for 5 to 7 months in 4. A quartz lamp of the Bach type, known as the high mountain sun light, was used. To obtain results it is necessary to induce an intense erythema, followed by edema and exudation. Vajano (Gior. ital. del. mal. ven., Feb., 1924).

### HERPES GENITALIS.

The term herpes "genitalis" is much to be preferred to the older designations: "progenitalis" and "preputialis," neither of which were strictly

accurate. A form known as "herpes gestationis," which occurs in parturients, is also recognized.

**SYMPTOMS.**—Burning and itching, with sometimes pain, precede the appearance of the vesicles. Usually there is but one group, but occasionally the number is greater. There are not apt to be as many vesicles in each cluster as is the case in herpes of the face. A reddened edematous base with a single or at most two or three distinct vesicles upon it is not uncommon. Certain sites upon the genitals seem to be favored by the disease. These, in the order of their frequency in men, are the sulcus, the reflected mucous membrane of the prepuce, the glans, the margin of the prepuce, and the skin on the shaft (F. B. Greenough).

In women the sites of preference are the skin of the vulva, the inner border of the labia majora, any part of the labia minora, the prepuce, the clitoris, and the orifice of the urethra. When the lesions are situated upon the mucous membranes the vesicles rupture early and the patient first notices an excoriation, covered by a whitish deposit. Upon the integument of the vulva or penis the vesicles look like tiny droplets of water. They rapidly lose their clear, shining appearance, however, owing to the increasing turbidity of the contents. Crusting follows, and if the disease is not irritated the process terminates by the falling of the scab in from one to two weeks. A pigmented spot remains. This eventually disappears. There is no scar.

There occur clinically two closely related toxic dermatoses of gestation. One of these is very rare and malignant—the so-called impetigo herpeti-

formis. The other or benign type is the so-called herpes gestationis. The malignity of the first named is due to its progressive character and the impossibility of antagonizing it. Whether **serotherapy** can arrest this form we do not know, because its infrequent occurrence gives no chance to test the resource. The controllability of the milder form is complete. The itching, which is the most burdensome symptom, ceases promptly under the treatment. The latter is simplicity itself. **Blood-serum** is obtained from a healthy pregnant woman and 10 c.c. (2½ drams) are injected subcutaneously in the gluteal region. The serum was from a gravida at the ninth month. Veiel (Med. Rec., from Münch. med. Woch., Aug. 27, 1912).

Itching is apt to be severe, especially in women. Neuralgic pain, simulating that of zoster, is sometimes felt. These cases should be regarded with suspicion, but it is not a wise measure to call every attack of this nature *shingles*.

The lesions in the male are usually situated in the line of the dorsalis-penis nerve. When close set the vesicles may coalesce.

**DIAGNOSIS.**—The recognition of the disease does not usually present any great difficulty, but care is sometimes needed in arriving at correct conclusions. The mental distress of the patient is generally out of all proportion to the severity of the disorder, and this, coupled with the ease with which the lesions may be confounded with the initial sclerosis of *syphilis*, makes the subject a fruitful field for the quack and the unprincipled practitioner. Many a young man has had his life made bitter and has parted with his years of hard-earned wealth because some such scoundrel has pronounced the simple herpetic lesion

exhibited a virulent chancre. If the truth might be known, many of the wrecks behind the bars of our insane asylums could be traced to this cause. On the other hand, the ease with which syphilitic infection may take place at the site of the herpetic vesicle or excoriation will make the careful practitioner exceedingly guarded in his statements to his patient. He is a physician of very limited observation indeed who has not seen an undoubted case of genital herpes linger along, getting worse instead of better, until it had assumed the classical features of a chancre or chancroid, to be followed by the disastrous results of the one or the other.

If there be a history of exposure to a probable source of infection, sufficient time to exclude the possibility of such infection must be insisted upon before a final answer be given.

The Wassermann reaction, carefully performed, may be a deciding factor as to whether the patient has syphilis or not. Much time may be thus saved from waiting for sufficient symptoms to make a positive answer warranted. This, in the case of *chancroid*, need be but a few days. The pain, the intense inflammation, the formation of a true ulcer, and the development of the single inguinal bubo will tell the story.

If haste is imperatively necessary the autoinoculability of the secretion may be tried.

If true *chancre* be expected, at least six weeks from the time of the exposure should be allowed to elapse before a definite decision can be rendered. The sluggishness of the lesion, the induration, the double inguinal enlargements, and the characteristic eruption will distinguish it.



**ETIOLOGY.** — Herpes genitalis occurs in both sexes, but with relatively greater frequency in the male than in the female. In persons subject to the disorder any irritation of the genital regions is likely to induce an attack. Ungratified sexual excitement, local uncleanness, coitus, masturbation, friction with the underclothing, passage in the male of a sound, or pressure of the saddle on horseback or the bicycle are common and fruitful sources of the mischief. In some women it appears at each catamenial epoch, preceding, accompanying, or following the period. It is frequent during pregnancy. Venereal disorders, such as gonorrhea and chancroid, as has been so well shown by Doyon, are apt to induce it. They are not, however, as he endeavors to show, its invariable precursors. Vaginitis and leucorrhea are prone to give rise to the disease, the irritating discharges acting as the exciting factor. Fournier and Unna have shown that it is very common in prostitutes and lewd women. In women infected by their husbands with syphilis or gonorrhea it is said to be infrequent.

Herpes genitalis is a disease of early and middle adult life. It rarely occurs in infancy and seldom after 50 years of age. Like herpes of the face, it sometimes appears to arise without appreciable cause. Disorders of digestion and constipation are named as exciting factors, but it is doubtful if such be the case.

A redundant prepuce is unquestionably a predisposing element in men. Balanitis is sometimes regarded as a cause, but the probability is that it is due to the same derangements that induce the herpes.

**PROGNOSIS.** — Herpes genitalis is a disease that recurs with exasperating frequency and occasionally makes life a burden to its victim. But, aside from the tormenting pruritus and the belief in its venereal origin, it is seldom that it gives rise to much that can be characterized as more than mere annoyance. The patient's fears need to be allayed and faulty sexual habits and hygiene corrected. The tendency of the trouble is toward rapid healing. Where ulceration results from the improper use of caustics the process may be much prolonged and phimosis with distinct narrowing of the preputial orifice may result.

**TREATMENT.** — Caustics should never be used in the treatment of herpes of the genital organs. Grave ulceration is liable to result and the more important factor of accurate diagnosis is almost sure to be clouded. The simplest antiseptic washes with absolute cleanliness are sufficient. Immersing the parts, where possible, in a warm solution of boric acid, or bathing them with the same twice a day and dusting afterward with **europhen** or **aristol**, is all that is needed. Weak solutions of bichloride of mercury, zinc sulphate, or potassium permanganate may be used. Duhring spoke highly of the following formula:—

℞ *Zinci sulphatis*,  
*Potass. sulphidi*,  
 āā ..... ʒj-ʒj (1.3-4 Gm.).  
*Spt. vini recti-*  
*ficati* ..... ʒj (4 c.c.).  
*Aquæ* ..... fʒvij (28 c.c.).

M. Sig.: Shake and apply frequently and freely.

All sources of irritation should be removed. **Borated cotton** makes a good covering.

In dressing the penis no bandage should be used. It interferes with the return circulation and is liable to induce phimosis.

A preparation of **arsenic** may be tried as a prophylactic, and **cold sponging** of the body should be practised daily. In persistent cases the use of the **faradic current** daily over the **spine** may be tried.

In patients with a long foreskin **circumcision** should be advised.

The writers outline the following treatment of this form of gestational autotoxemia: (1) **Rest** in bed. (2) **Absolute milk diet**. (3) The use of **laxatives** daily, or of **purgatives** every three days with **saline enemata** on the intervening days. (4). A **warm starch bath** lasting one-half hour every day or every other day. (5) The use twice a day of:—

℞ *Chloral hydrate* ... ʒiiss (10 Gm.).  
*Distilled water* .... Oij (1000 c.c.).

After this, the application to the itching parts of a powder made up as follows:—

℞ *Salicylic acid* .... gr. xv (1 Gm.).  
*Powdered starch,*  
*Powdered talc,*  
of each ..... ʒxiiss (50 Gm.).  
*Zinc oxide* ..... ʒiiss (10 Gm.).

If the itching is intolerable, it may be necessary to administer **chloral hydrate** internally. In case the stomach does not tolerate this drug, it should be given *per rectum* in doses as high as 2 Gm. (30 grains), dissolved in boiled water or milk. Rudaux, Grosse, and le Lorier (Thérap. obstét.; Med. Rec., Jan. 18, 1913).

In recurrent herpes in children, the writer advises that adenoids, dental trouble, defective eyesight, and intestinal worms, be remedied. Two to 5 grains (0.12 to 0.3 Gm.) of **quinine** at the beginning of an attack may abort it, as also **collodion** locally before the vesicles have matured, or **calamine**

**lotion** if already formed. H. G. Adamson (Brit. Jour. of Child. Dis., July, 1916).

Case in which herpes genitalis in a man was apparently traceable to herpes of his wife's throat which he had treated by swabbing, thus infecting his hands.

According to the researches of Levaditi and others, herpes is due to a neurotropic virus which may be grouped with the viruses of rabies, poliomyelitis, encephalitis, and vaccinia. The encephalitic virus contained in the saliva is essentially identical with that of herpes. Belgodère (Ann. des mal. vén., Jan., 1924).

ROSE HIRSCHLER,  
Philadelphia.

**HETEROCHYLIA.** See STOMACH, DISEASES OF.

**HEXAMETHYLENAMINE** (methenamine; hexamethylenetetramine; urotropin; cystogen; cystamine; aminoform; formine) is an organic substance made by passing dry ammonia gas into a solution of formaldehyde and having the chemical formula  $(CH_2)_6N_4$ .

Prepared first by Butlerow in 1860, methenamine was introduced into medicine by Nicolaier and Bardet, the former of whom recommended it for the purpose of preventing the deposition of urates. Soon after, its value as a urinary antiseptic became recognized, and it came into widespread use almost exclusively for this purpose until in 1908 Crowe and in 1910 Barton showed that it was eliminated also by other channels and its field of employment was thereafter extended.

Methenamine occurs as a white, crystalline powder which is odorless, tasteless, and freely soluble in water, though less soluble in alcohol and almost insoluble in ether,

**PREPARATIONS AND DOSE.—**

*Methenamina* is now the name under which the drug is officially recognized. Various special appellations have also been given to the identical substance, most of which have been mentioned above. None of the unofficial preparations set free more formaldehyde than the chemically pure hexamethylenamine (Crowe). Helmitol, which is an allied but not identical preparation, is hexamethylenetetramine anhydromethylene citrate  $[C_7H_6O_7 \cdot (CH_2)_6N_4]$  and has properties similar to those of the official compound.

The single dose of hexamethylenamine ranges from 5 to 60 grains (0.3 to 4 Gm.), the average amount for purposes of genitourinary antiseptics being 10 grains (0.6 Gm.). The larger doses have been used chiefly to exert an antiseptic effect in the cerebrospinal fluid or other body humors into which the drug is excreted only in small amount.

The dose of hexamethylenamine *per diem* has been carried by Crowe as high as 200 to 300 grains (13 to 20 Gm.), the drug being administered in part by rectum, without untoward effect. In many cases, however, the giving of 75 grains (5 Gm.) a day for ten days was found to bring on symptoms of irritation of the urinary tract. For ordinary purposes, 8 to 15 grains (0.5 to 1 Gm.) of the drug three times a day can be considered sufficient in many instances, and safe almost invariably, though in the notable proportion of cases which fail to split off formaldehyde easily from the hexamethylenamine larger amounts can be given without risk.

**MODES OF ADMINISTRATION.—**Hexamethylenamine should

always be given well diluted with water, even when used in small doses, as the likelihood of an irritant action on the urinary tract is thereby rendered much less. According to Crowe, doses of 10 or 15 grains (0.6 to 1 Gm.) should always be dissolved in 250 or 300 c.c. (8 or 10 ounces) of water. The same observer, where large amounts of the drug are to be administered, gives it in the dose of 1 to 3 grains (0.06 to 0.2 Gm.) in every ounce (30 c.c.) of water or liquid food—milk or broth—the patient takes, and finds it often possible thus to give from 60 to 100 grains (4 to 6½ Gm.) a day without the patient's knowledge and without untoward phenomena. Where the patient is very ill, Crowe has given the drug by rectal drip—50 to 100 grains (3.25 to 6.5 Gm.) in a quart (liter) of salt solution—given slowly.

Methenamine and acid sodium phosphate may be given in the same solution where the urine is to be acidified to enhance liberation of formaldehyde from the former. The theoretic incompatibility between the 2 drugs is of no practical importance. A suitable solution is: Methenamine, 8 Gm. (2 drams); acid sodium phosphate, 24 Gm. (6 drams); distilled water, to make 100 c.c. (3¼ ounces). Average dose, 1 teaspoonful. B. Fantus and C. M. Snow (Jour. Amer. Pharm. Assoc., Sept., 1925).

**CONTRAINDICATIONS.—**In the presence of acute nephritis the possible irritant effect of methenamine indicates either marked reduction of dosage or omission of the drug.

In hematogenous infections of the kidney the effects of hexamethylenamine are uncertain and capricious, and the drug may cause irritation of the urinary tract which will have the effect of keeping up the inflammation. Phenyl salicylate, 4 cachets of 15

grains (1 Gm.) each daily,—with copious drinking of distilled water, permanent catheterization, and autogenous vaccine treatment,—is to be preferred. Rovsing (Rev. clin. d'urol., Nov., 1913).

In some individuals hexamethylenamine tends to call forth or aggravate headache. A relative contraindication to the drug is here afforded.

The writer has tabloids made up coated with keratin, in which form the drug does not split in the stomach and cause gastric symptoms. The urine must be kept in an acid state with either acid sodium phosphate or ammonium benzoate. In acute colon bacillus infection he recommends alkaline treatment of the urinary tract before resorting to hexamethylenamine, which should then be given to the limit of tolerance, whether the kidney or the bladder is involved. J. W. T. Walker (Med. Press and Circ., ci, 304, 1916).

#### PHYSIOLOGICAL ACTION.

—**Externally**, hexamethylenamine is a rather inert substance. Micro-organisms exposed to it in 5 to 10 per cent. solutions were found by Burnam entirely to escape injury. Nicolaier had already found, however, that the drug acted on bacterial cultures at body temperature, and concluded that it exerted an antiseptic effect owing to the liberation from it of formaldehyde. This is now the established view of the mode of action of hexamethylenamine, and readily accounts for the lack of effect evident *in vitro* in the cold. Burnam found the drug unirritating and used it in the bladder and kidney in a 50 per cent. solution without either any ill result or any appreciable effect on the infection present.

Heating hexamethylenamine enhances its disinfecting power. At 37° C. a 0.5 per cent. solution has as

powerful a sterilizing action as a 2 per cent. solution at 17° C. The presence of albumin does not interfere with its action. Test-tube experiments showed that minute amounts of the drug added to sputum arrest its putrefaction. Zak (Wiener klin. Woch., Jan. 25, 1912).

**Internally**, hexamethylenamine, upon entering the blood, is believed to remain unchanged. It begins very promptly to be eliminated in the urine, but meanwhile it circulates widely in the body, and enters the bile, cerebrospinal fluid, saliva, milk, as well as other secretions, at least in small amounts. Crowe found it in synovia and the fluid of a pleural effusion, while Barton and others concluded from their clinical experiences that it must be eliminated by the mucous membranes of the middle ear, accessory nasal sinuses, and respiratory passages as a whole. The possibility that formaldehyde may be set free from hexamethylenamine in the various body fluids referred to, while generally recognized for a time, seems to have been disproved, excepting as regards the urine, by Hanzlik and Collins.

After administration by mouth, hexamethylenamine appears in the bile and pancreatic juice of dogs. It finds its way into the bile both through the liver and through the wall of the gall-bladder. When given to man in sufficiently large doses (75 grains—5 Gm.—per diem) it appears in the bile in quantities sufficient to exercise a decided bacterial action. S. J. Crowe (Johns Hopkins Hosp. Bull., April, 1908).

If a patient receives 10 or 15 grains (0.65 or 1 Gm.) of urotropin it can be found in a short time in cerebrospinal fluid obtained by puncture. The average time would seem to be from thirty minutes to one hour. The cerebrospinal fluid possesses under

these circumstances a germicidal power which the ordinary fluid does not. Crowe (Johns Hopkins Hosp. Bull., April, 1909).

Experiments indicating that hexamethylenamine is excreted unchanged in the saliva. The greatest amount of the drug seemed to be excreted during the first thirty minutes after its administration. No free formaldehyde was found. It is known that the liberation of formaldehyde is a very slow process. Stagnation of the urine, bile, or cerebrospinal fluid in the body would probably give time for this process to occur; but in the case of saliva there is no stagnation, and consequently it is rather improbable that any effective quantity of formaldehyde could ever be liberated. P. J. Hanzlik (Jour. Amer. Med. Assoc., June 11, 1910).

Even after rather large doses of hexamethylenamine, there appear in the bile, sputum, saliva, and cerebrospinal fluid only traces of the drug,—less than 1:150,000. It was also ascertained by the author that *in vitro* a 1:50,000 formaldehyde solution, and a 5 or 10 per cent. hexamethylenamine solution, are both incapable of destroying or inhibiting the growth of various micro-organisms, such as the streptococcus, staphylococcus, and typhoid bacillus. Consequently, the use of hexamethylenamine for the curing or bettering of, or as a prophylactic against infections of the bile passages, respiratory passages, and cerebrospinal system is illusory. C. F. Burnam (Arch. of Int. Med., Oct., 1912).

The writer found granular casts, red cells, and massive albumin in a patient free of renal or cardiac disease, who had taken large amounts of hexamethylenamine for colon bacilluria. The formaldehyde may have permanently damaged the kidneys. Nine years later, however, his health was apparently normal. O. Leyton (Lancet, July 22, 1916).

Report of experiments in human subjects indicating that either no formaldehyde or only traces of it are

liberated from methenamine in the blood-stream and body tissues. Intravenous injections of large doses in animals did not yield evidence of decomposition of the drug. In buffer phosphate mixtures *in vitro* containing serum protein only traces of formaldehyde could be detected at a hydrogen ion concentration approximating that of human blood. In doses of 1 to 5 Gm. (15 to 75 grains) the total urinary excretion of methenamine ranged from 32 to 85 per cent., regardless of dosage, diuresis or clinical condition. Sodium bicarbonate by the mouth increased the excretion in 2 persons—to 100 per cent. in 1 instance. This indicates that ordinarily hydrolysis or decomposition of the drug takes place in the alimentary canal, mainly by the acid of the gastric juice. The author's conclusion is that the only field for the drug is in pathologic conditions of the bladder, provided the urine be markedly acid. F. De Eds (Arch. of Int. Med., Oct., 1924).

Little information is available concerning the systemic effects of methenamine, which are, however, of but slight importance since such effects in man would in practically all cases be overshadowed by those of the formaldehyde set free. Experimental animals are very tolerant of the drug, rabbits, *e.g.*, withstanding a dose, given subcutaneously, equivalent to about 18 ounces in the human subject. In these animals the drug escapes in the urine wholly unaltered, no formaldehyde being ever set free. Observations such as these seem clearly to show that renal and vesical irritation following the use of methenamine in man is due not to the drug itself but to formaldehyde.

The localities at which the formaldehyde is set free in the system are believed to be the kidney and bladder. Fleig showed in oncometric experiments that primary vasoconstriction,

followed by vasodilation, is brought about in the kidney by hexamethylenamine. According to Fullerton, the drug possesses some diuretic action.

*Elimination* of hexamethylenamine in the urine upon its administration by mouth has been shown to begin in fifteen and even ten minutes. According to Burnam, the drug is excreted actively for eight hours, after which the amount passing out dwindles markedly until in twenty-four hours, even after a large dose, the drug can no longer be detected. As for the formaldehyde set free and eliminated in the urine, observations of the same author indicate that its amount and even its appearance at all depend in some measure upon the dose of hexamethylenamine taken. Individual variations are also a prominent factor, and there appears to be no certainty that, in a given person, formaldehyde will be excreted unless the dosage is progressively increased until this product can be actually detected through a chemical test.

The test recommended by Burnam for the detection of formaldehyde in the urine of patients taking hexamethylenamine is performed as follows: To about 10 c.c. of the urine in a test-tube at body temperature are successively added (1) 3 drops of a 0.5 per cent. solution of phenylhydrazine hydrochloride; (2) 3 drops of a 5 per cent. solution of sodium nitroprusside; (3) a few drops of a saturated solution of sodium hydroxide, poured along the side of the test-tube. If formaldehyde is present a deep purplish-black color is seen as the alkaline solution diffuses through the urine; this quickly changes to a dark green, gradually assumes a lighter shade of the same color, and

finally turns to pale yellow. Where formaldehyde is not present, on the other hand, a reddish color instead develops, gradually turning to light yellow.

Burnam test applied to the urine of over 250 patients taking hexamethylenamine by mouth. Only 130, or 52 per cent., showed the presence of formaldehyde. The reaction of the urine is of no importance. Alkalies taken with or in combination with hexamethylenamine have no effect on excretion. The duration of excretion of formaldehyde is about four to six hours. Increase of dosage does not affect excretion in negative urines. L'Esperance (Boston Med. and Surg. Jour., Oct. 24, 1912).

In doses of from 5 to 10 grains (0.3 to 0.6 Gm.), three times a day, not more than 2 patients out of 10 show any decomposition of the drug into formaldehyde. At least 60 per cent. show such decomposition, however, when from 20 to 30 grains (1.3 to 2 Gm.) are given every four to six hours. Clinically, it is the free formaldehyde which is the effective agent. Its liberation appears to be due to some specific activity of the renal epithelium. There is no fixed dose of hexamethylenamine. The only toxic effect is occasioned by the liberation of formaldehyde, and when this does not occur, it is safe to increase the dose until it appears. The proper treatment is to give a dose just sufficient to cause bladder irritation; improvement will then generally follow so rapidly that long-continued use of the drug will not be required. C. F. Burnam (Archives of Intern. Med., Oct., 1912).

It has been demonstrated that hexamethylenamine is more effective as a urinary antiseptic if the reaction of the urine is acid than where it is alkaline. Burnam found, indeed, that the greatest decompositions of hexamethylenamine into formaldehyde occurred in highly acid urines, but in

definitely alkaline urines he also occasionally met with large amounts of formaldehyde.

Hanzlik and Collins prefer the phloroglucin test for formaldehyde to that used by Burnam.

The phloroglucin test is the most delicate and useful test for free formaldehyde. The reagent used consists of phloroglucin (reagent, Merck), 0.1 Gm., dissolved in 10 c.c. of 10 to 20 per cent. sodium hydroxide. When first prepared the solution acquires a bluish-violet color, but on standing becomes entirely colorless or with at most a yellowish tinge. The reagent may be used freshly prepared, as the violet color does not interfere. The test is performed by the addition of about 0.5 c.c. of the reagent to about 1 to 2 c.c. of the fluid containing formaldehyde. A deep bright red appears instantaneously with higher concentrations of formaldehyde, but with lower concentrations it requires about one-half to one minute for the color to reach its maximum intensity. The color persists for at least five minutes with dilute solutions, and much longer with the concentrated formaldehyde solutions. The test is directly applicable to all body fluids except whole blood and bile. The reagent added to water alone gives a clear colorless solution.

Alkalies prevent, while acids facilitate, the liberation of formaldehyde from hexamethylenamine in all body fluids. Liberation of formaldehyde depends on the excess hydrogen ion concentration of the solution above the neutral point. Administration of monosodium phosphate with hexamethylenamine renders the urine acid and facilitates the liberation of formaldehyde. Administration of alkali inhibits the liberation of formaldehyde. The beneficial therapeutic effects of hexamethylenamine depend on the liberated formaldehyde. It is irrational to prescribe alkalies (bicarbonate and citrate) with hexamethylenamine. A urine previously alkaline can be rendered acid in about

five hours by the administration of 13 Gm. (200 grains) of monosodium phosphate. If the occurrence of diarrhea is objectionable, the dosage of the phosphate may be reduced. P. J. Hanzlik and R. J. Collins (Arch. of Intern. Med., Nov., 1913).

Formaldehyde is a weak and relatively slow germicide, but even in high dilutions exerts a powerful inhibitory influence on bacterial development. A dilution of 1:16,000 is totally inhibitory to *Bacillus typhosus* for twenty-four hours, and 1:6000 is completely germicidal at the end of that time. A dilution of 1:30,000 definitely restrains the growth of the organism, but a dilution of 1:40,000 has no apparent effect.

Of 23 urines obtained by catheterization of the ureters after hexamethylenamine administration, only 5 showed formaldehyde, and these had only a 1:60,000 of it. The 18 negative urines all gave a positive test for hexamethylenamine. The latter, as it is excreted from the alkaline blood, does not remain at the level of the kidney long enough to give good conversion, and even with high acidity and high concentration the formaldehyde at this level is seldom enough to furnish antiseptics.

Only 4 of the author's 116 cases, however, failed to show formaldehyde in the bladder, but only 8 cases, or about 7 per cent., revealed formaldehyde in the germicidal strength (1:7000) and 5 of these had been given acid sodium phosphate. Fifty-five per cent. of the cases gave at some one examination a 1:30,000 test or better.

A formaldehyde content of antiseptic value cannot be expected with a urinary acidity below 2 c.c. of tenth-normal sodium hydroxide for 10 c.c. of urine (using phenolphthalein as indicator).

The urine of a patient on hexamethylenamine, if acid, will after standing give a higher test for formaldehyde than when fresh. Feeding acid sodium phosphate, boric acid, benzoic acid, or salicylic acid will

increase urinary acidity where it is low, and in these cases very definitely increase the amount of formaldehyde in the urine. The effect of any of these acid-producing drugs will wear off after a time. When this occurs one can again raise acidity by substituting one of the other drugs in its place, and by thus alternating the drugs acidity may be maintained for some time in some cases, but not satisfactorily in all. It is best not to give these drugs *with* the hexamethylenamine.

In cases of hyperacidity or poor gastric motility there is sufficient conversion of hexamethylenamine to formaldehyde in the stomach to considerably lower the formaldehyde content in the urine. Hexamethylenamine may be given in salol-coated pills in cases of gastric irritability.

Formaldehyde appears in an acid urine after the ingestion of an average dose (15 grains) in from twenty to thirty minutes, and will have disappeared in from eight to sixteen hours. An eight-hour interval of administration will give good results in routine use, although a higher concentration is obtained with more frequent introduction.

The dilution of the drug on excretion largely influences the amount of it that is subsequently converted, as the higher its concentration, the more readily will it be broken down. A polyuria, through the effect of dilution, will largely offset the advantage of large doses.

Disease of the kidney has no influence on the formaldehyde content in the urine. At the level of the kidneys hexamethylenamine in doses of 15 grains three times a day has no antiseptic value.

Formaldehyde is present in the bladder urine in some amount in practically every case receiving 15 grains of hexamethylenamine by mouth three times a day, but this dosage is too small to yield a reasonable antiseptic benefit in every case. F. Hinman (Jour. Amer. Med. Assoc., Nov. 1, 1913).

**UNTOWARD EFFECTS.**—Bladder irritation, manifested in a sensation of heat or actual burning along the urinary tract, with or without frequent or painful micturition and strangury, is the commonest untoward occurrence following the administration of hexamethylenamine. The irritation is not due to the drug itself, but to the formaldehyde liberated from it, L'Esperance having observed in a large series of cases that patients not excreting formaldehyde were symptomless regardless of the amount of hexamethylenamine taken. Burnam found, moreover, that the tolerance of the bladder mucosa to formaldehyde solution directly introduced varies greatly in different individuals. It need not therefore seem surprising that whereas in occasional cases of already sensitive bladder,  $7\frac{1}{2}$  grains (0.5 Gm.) of hexamethylenamine taken two or three times a day is sufficient to produce vesical irritation, daily doses as large as 150 grains (10 Gm.) have been taken without any disturbance resulting. The sensitiveness of the urinary system to the formaldehyde from hexamethylenamine has even been noticed to vary at different times in the same individual.

Other effects occasionally observed after the use of this drug are hematuria or hemoglobinuria, headache, tinnitus, a skin rash resembling that of measles, gastric irritation, diarrhea, and abdominal pain. According to Coleman, blood appearing in the urine after hexamethylenamine is derived from the bladder. Frothingham refers, in addition, to a pain in the back denoting renal congestion, and to the appearance of albumin and casts in the urine. Albuminuria



rarely develops unless some involvement of the kidneys is already present.

Among 95 cases in which the average dose of hexamethylenamine given was 75 grains (5 Gm.) a day for ten days, painful micturition and hematuria occurred in 7 instances. In each of 3 cases which terminated fatally there was a well-marked hematuria, but at the post-mortem examination it was apparent that it had its origin from the mucous membrane of the bladder and was not due to an acute renal irritation. In the remaining 4 cases the urine rapidly became normal on the withdrawal of the drug. Producing active diuresis by forcing liquids is also useful. Crowe (Johns Hopkins Hosp. Bull., Sept., 1912).

A case of cystitis due to hexamethylenamine has been reported by Fullerton. The urine was sterile. Some of the symptoms persisted for several weeks.

Report of a case in which large doses of hexamethylenamine caused intense cystitis. The symptoms began after 200 grains (13 Gm.) had been taken over a period of four days. The woman voided urine every ten or fifteen minutes and had pain and burning, especially at the end of urination. The next day another drug was prescribed and the hexamethylenamine ordered stopped. Through a mistake, the patient received 45 grains (3 Gm.) more of the drug during the day, and in the evening, twenty-four hours after the first symptoms, which had increased in severity during the day, she had marked hematuria, passing many small blood-clots as well as pieces of bladder membrane several centimeters square. The urine was acid and contained pus and a considerable amount of albumin. The drug was stopped and appropriate treatment of the cystitis instituted. For three nights and two days after the onset of the hematuria, blood-clots and bladder membrane were passed. Red blood-cells were passed for ten days. The pus and albumin gradually

disappeared. Fullerton (Jour. Amer. Med. Assoc., Jan. 13, 1912).

The most common cause of this condition is abnormally high urinary acidity. With low acidity the efficiency of the drug disappears. A middle course is desirable. Wiseman (Amer. Jour. Med. Sci., Aug., 1917).

In nearly all instances discontinuance of the administration of methenamine after untoward phenomena have appeared is promptly followed by cessation of the latter. Sometimes merely a reduction in dosage will be indicated.

In the rubber industry, methenamine is scattered through the rubber during the mixing process in 0.1 per cent. strength. The drug poisoned 60 employees in a rubber factory.

Acute dermatitis of the exposed surfaces was the principal symptom. Itching was extreme. Many patients later had indolent, deep infections that resisted treatment. Lotions and protective ointments were found to be of some value, while the infections were treated by poultices, incisions and drainage. All efforts to prevent the development of new cases were unsuccessful until elimination of methenamine from the rubber stock had become complete. H. J. Cronin (Jour. Amer. Med. Assoc., July 26, 1924).

**THERAPEUTIC USES.**—As a urinary antiseptic methenamine was long generally conceded to be without a peer. In cases of **cystitis** and **pyelitis** due to micro-organisms other than the gonococcus and the tubercle bacillus, its use has been widespread. The dose given in these conditions ranges from 4 to 15 grains (0.25 to 1 Gm.), this being administered two or three times daily. Colon-bacillus infections are in a considerable number of cases effectually overcome by methenamine.

In a case of **tabes dorsalis** in which relaxation of the sphincters was fol-

lowed by the development of a rather severe cystitis, 10 grains (0.6 Gm.) of hexamethylenamine were given hypodermically three times daily for a period of two weeks, without producing local irritation. As a prophylactic measure where catheterization or other genitourinary manipulation is necessary, this drug should be given hypodermically until its administration by mouth can be taken up. F. F. Gundrum (Calif. State Jour. of Med., July, 1911).

In **urethritis**, even of the specific form, the drug has also been employed with asserted advantage by some. In these cases the dose should seldom exceed 5 grains (0.3 Gm.) and usually be even less, though administered four times a day.

In the prophylaxis of urethritis and cystitis, *e.g.*, where instruments are to be introduced in the bladder or ureters, hexamethylenamine is definitely indicated.

**Phosphaturia** can often be prevented or overcome with hexamethylenamine even where other drugs or dietetic measures have failed.

A patient with locomotor ataxia, under treatment for a year and a half, had suffered from **phosphaturia** for from six to twelve months before he came under observation. Every measure tried to relieve this condition was without success until hexamethylenamine was used, and from that time the phosphaturia gave no more trouble.

Although the patient had been taking the remedy faithfully for a year and a half, no unfavorable effects have been noted. At first 0.5 Gm. (8 grains) four times a day was given, and then the administration gradually reduced to once a day. This did not hold the phosphaturia in check, however, and the remedy had again to be given oftener. Osborne (Monthly. Cyclo. of Pract. Med., Sept., 1910).

Buttersack has advocated the persistent administration of hexamethylenamine in **scarlet fever** to prevent the development of nephritis. Of 34 case in which the drug was given up to the twenty-first or twenty-fifth day, none developed nephritis, though in a few instances a trace of albumin suddenly appeared, with occasional casts, but without altered quantity of the urine or edema. Leech, Morris and others have had similar favorable experiences with the remedies.

In **gall-bladder infections** hexamethylenamine, according to some, proves of value, bacteria in this organ being rapidly destroyed by the formaldehyde set free. In **typhoid fever** especially has the drug been used, in order to prevent relapses arising from storage of bacilli in the gall-bladder with subsequent liberation and reinfection of the bowel; to prevent post-typhoid cholelithiasis, and to sterilize the patient's urine and prevent transmission of the disease. The occasional genitourinary complications of typhoid fever can also probably be prevented with hexamethylenamine. Crowe states that the dose necessary rapidly to free the gall-bladder of typhoid bacilli is 75 grains (5 Gm.) a day, and that usually one or two doses are sufficient. Since the degree of formaldehyde liberation varies in different individuals and at different times, however, it seems evident that no fixed rule as to dosage can be laid down.

Hexamethylenamine recommended in doses of 30 to 45 grains (2 to 3 Gm.) per day in **acute infections of the biliary system**, whether due to pyogenic cocci, to the colon, or to the typhoid bacillus. The author also uses it for the preoperative sterilization of infected gall-bladders. That

the drug is partly excreted in the bile he was able to prove in cholecystostomized patients. A. Chauffard (*Semaine méd.*, No. 10, 1911).

Hexamethylenamine found useful for **prevention of excessive abdominal tympany after operations**. Ten grains (0.65 Gm.), dissolved in a glassful of water, are given every two hours between meals while the patient is awake, for two days previous to operation. Immediately after operation the nurse dissolves 120 grains (8 Gm.) of the drug in a quart of drinking-water, and as soon as the patient complains of thirst small quantities of this are given at a time, the amount being cautiously increased as the stomach becomes retentive.

Hexamethylenamine seems to be beneficial in non-operative cases of infection of the bowel and bile-tract. The author has never been forced to operate upon a case of **bile-tract infection** or obstruction from **gall-stones** during the acute attack, always carrying them over the stage of pain and fever by rest in bed, restriction of diet, avoidance of purges, administration of drugs quieting peristalsis, and the routine use of hexamethylenamine every two hours for periods of three days at a time. In **acute appendicitis**, where the proper facilities for operation are not at hand, he has seen many cases settle down into a quiet stage by starvation and the measures just mentioned. In **catarrhal jaundice** he reports satisfactory results following a treatment including 10 grains (0.65 Gm.) of the drug every 2 hours during the waking period. G. P. La Roque (*Therap. Gaz.*, July, 1913).

Methenamine, when given *intravenously*, inhibits bacterial action and kills bacteria by reason of the formaldehyde formed from it in the nascent state in the affected tissue through local acidosis. Injected in a 40 per cent. solution, the drug promotes exchange of water, salts and colloids between the blood and tissue fluids, encourages absorption and increases the amount of urine. Used intravenously in 500

cases, the drug began to be excreted in the urine in 10 to 15 minutes, and this continued for 36 to 48 hours. Formaldehyde appeared in the urine in 5 to 10 minutes. The dose of the 40 per cent. solution was 10 c.c. (2½ drams), administered daily for 10 to 12 days. No hematuria resulted, though there was some tenesmus. The disorders showing rapid benefit from such injections were **suppurative cholangitis**, **catarrhal jaundice** from ascending cholangitis, recurrent **spasms after gall-stone operations**, **postoperative bladder paralysis**, **obstinate furunculosis**, and threatened **general sepsis**. In the last-mentioned cases the process is often checked by 1 or 2 injections. G. von Takáts (*Arch. f. klin. Chir.*, Sept. 22, 1923).

In various **respiratory disorders** experiences with methenamine have been stated to have shown it useful as a destroyer of mucous-membrane infections, although clinical experiments conducted for the purpose of finding out whether or not formaldehyde is excreted in the mucous secretions have not yielded confirmatory results.

In **acute coryza** favorable results from hexamethylenamine have been reported by several observers. According to Austin Miller, it acts promptly and efficiently in most cases, the irritating, watery secretion of coryza being arrested, and the fever, aching and malaise of **influenza** likewise being overcome. The drug should be taken at the earliest possible moment—when the nose begins to feel "stuffy." In colds that have already been present several days the results are less gratifying. The greatest value of the drug, according to the experience of one of the writers, is in the prevention of the tracheobronchitis which frequently becomes superadded to acute coryza.

At the onset of a cold the author prescribes 3 drams (12 Gm.) of hexamethylenamine divided into 12 powders,—1 powder to be taken in a goblet of cold water four times daily. Copious water-drinking is encouraged, which lessens the possibility of bladder irritation. The latter is the only ill effect of the drug, but it occurs only occasionally and ceases at once when the medicine is discontinued. Austin Miller (*Jour. Amer. Med. Assoc.*, June 10, 1911).

In **acute bronchitis** hexamethylenamine was found by Eisenberg promptly to cause the establishment of free secretion, with great relief to cough, and to make all other symptoms disappear within three to five days. Heitmüller reported in **chronic bronchitis** a change in the character of the sputum from mucopurulent to mucoid, together with diminution in its quantity. **Acute tonsillitis** may be favorably influenced by hexamethylenamine, but in lobar pneumonia and pulmonary tuberculosis it is doubtful if the drug is of any value (Crowe).

Hexamethylenamine employed in all cases of common colds and in patients suffering from **acute or chronic bronchitis**. In colds no other remedies were employed except an initial purgative, with subsequent care that the bowels remained open. Large doses were found best, and as a routine the author gives 10 grains (0.65 Gm.) dissolved in a glass of water four times daily for three to seven days, after which the drug is discontinued. The patient is instructed to drink water copiously. But one patient complained of any irritation of the bladder, which ceased promptly after omission of the drug. Two cases of chronic antrum infection which had resisted operative measures and prolonged local treatment induced the authors to recommend hexamethylenamine as a prophylactic against sinus infection

from common colds. In both acute and chronic bronchitis hexamethylenamine produces results above comparison with the usually employed remedies. It is decidedly effective in colds, even when the bronchitis stage has been reached, but its chief value is in preventing this. Some cases do not respond to it and in these it is presumed structural changes have occurred. D. Vanderhoof (*Jour. Amer. Med. Assoc.*, Feb. 3, 1912).

In **suppurative otitis media** and in **accessory sinusitis**, acute or chronic, Barton and Brown were convinced of the value of methenamine in a number of cases. Barnes referred to the prompt control of aural discharges by hexamethylenamine. Barton reported having found the drug eliminated by the mucous membrane of the middle ear and sinuses, as well as that formaldehyde was sometimes present in the discharges. The drug has been recommended as a prophylactic of otitis media in infectious diseases commonly complicated by it, and its use has also been advocated prior to surgical operation upon the middle ear or mastoid and the nasal sinuses.

Upon demonstrating experimentally the appearance of hexamethylenamine in the cerebrospinal fluid, Crowe administered it to all cases in which meningeal infection is a possible or threatened complication, including cases of **compound skull fracture, tumors of the hypophysis** with neighborhood symptoms necessitating operative procedures through the nose, and **postoperative cerebrospinal fistula**. The statistical results obtained in a large series of cases appeared to this author to be clearly indicative of a favorable prophylactic influence. The drug has been used with asserted advantage to prevent

complications in **gunshot wounds of the head**, and also as a preliminary to **lumbar or ventricular puncture**. For all these purposes the dose used must be rather large—from 40 to 150 grains ( $2\frac{1}{2}$  to 10 Gm.) a day, preferably at least 75 grains (5 Gm.). This is best divided into small doses, given freely diluted in water every half-hour; or, the drug may be given with liquid food.

Hexamethylenamine given as a routine measure in 35 consecutive cases of undoubted **basal fracture**, with bleeding or escape of cerebrospinal fluid from the nostrils or ears, without a single instance of secondary meningeal infection. There had been nine deaths ascribed to meningeal infection or brain abscess among 35 earlier cases to which hexamethylenamine had not been given.

Among 20 cases of **compound fracture of the vault**, similar in that there was laceration of the meninges and underlying cortex in each instance, hexamethylenamine was not given and the mortality from infection was 50 per cent. in 8 of the earlier cases. To each of the remaining 12 cases the drug was given immediately after the injury and at frequent intervals thereafter; 10 recovered.

In 40 cases of **hypophysis tumor** from 40 to 60 grains (2.6 to 4 Gm.) of hexamethylenamine were given during the twenty-four hours preceding operation, and even larger amounts for several days after operation. In 32 cases there were no post-operative complications whatever; in 9 cases there was an escape of cerebrospinal fluid through the nose for several days following the operation, together with an elevation of temperature, headache, slight stiffness of the neck, etc. Three of these finally succumbed with meningitis; the other 6 cases recovered. Crowe (Johns Hopkins Hosp. Bull., Sept., 1912).

A urinary acidity of pH 5.6 to 5.8 is required for the therapeutic action of

methenamine. Since in infants the average urinary acidity values lie between pH 6.4 and 7.6, artificial acidification of the urine should always be provided for in giving methenamine in infants. The necessary acidification in the infant is obtained only with 0.8 to 1 Gm. of hydrochloric acid a day. If an adequate acidity is thus provided for, 0.25 Gm. (4 grains) is a sufficient dose of methenamine. II. Langer (Zeit. f. Kinderh., Mar. 7, 1924).

During epidemics of **cerebrospinal meningitis** and **acute poliomyelitis** the prophylactic administration of methenamine has been advocated, notably by Flexner and Clarke. A curative influence also seemed to have been established in the sense that in cases of acute poliomyelitis treated with the drug in the prodromal stage, subsequent paralysis might in the majority of cases be prevented. Josefson reported that of 8 cases in which treatment was begun on the first, second or third day, each recovered without paralysis.

The fact that hexamethylenamine has been found to enter synovial fluids suggested its utility in cases of arthritis. The form of this condition in which it has been chiefly tried is **gonorrheal arthritis**. Full doses were found by Crowe in a case of this kind to cause a marked decrease and in ten days complete disappearance of the organisms. The use of the drug has also been advised in **pneumococcic arthritis**.

Prouty reported a case of **orchitis** developing during an attack of tonsillitis, in which methenamine appeared to yield excellent results.

In certain eye affections, including **iridocyclitis** with **hypopyon**, and **sympathetic ophthalmia**, methenamine has seemed useful to Dinkelspiel and others,

Hexamethylenamine used to arrest fermentation in the stomach content in case of stagnation from **stenosis of the pylorus**. A patient with a **gastric ulcer** took 0.5 Gm. (8 grains) of the drug twice a day for four days and the eructations and stomach content became odorless, but he complained of transient burning in the stomach, due possibly to the drug. Zak (Wien. klin. Woch., Jan. 25, 1912).

Doubts as to the value of hexamethylenamine in conditions other than genitourinary have been expressed by Burnam and others, who consider, on the basis of estimations of the amount of hexamethylenamine or formaldehyde in the bile, sputum, saliva and cerebrospinal fluid after administration of full doses of the former drug, that the resulting solutions of formaldehyde in these fluids are too attenuated to exert any useful antiseptic effect. Hanzlik and Collins deny completely the splitting off of formaldehyde from hexamethylenamine in any of the body fluids except those which are acid, *viz.*, the gastric juice, and, in most instances, the urine.

After administration, hexamethylenamine is present, but does not liberate free formaldehyde in the blood, cerebrospinal, pleural, pericardial, and synovial fluids, the vitreous and aqueous humors, and the urine, when truly alkaline. Formaldehyde is liberated in urine which is truly acid, and in the acid gastric contents. The authors do not positively deny the possibility of benefit from the use of hexamethylenamine where there is bile infection. They state that, on account of the rapid absorption of the drug and the usual alkalinity of the bowel contents, no bactericidal action can be expected in the intestinal canal. Many of their experiments revealed, however, formaldehyde in the intestinal contents. P. J. Hanzlik and R. J. Collins (Arch. of Int. Med., Nov., 1913).

Methenamine is best given in aqueous solution, in an initial dose of  $7\frac{1}{2}$  grains (0.5 Gm.), along with 5 grains (0.3 Gm.) of acid sodium phosphate or benzoic acid, 3 times a day. It may be increased without ill effects up to 50 grains (3.2 Gm.) daily, until free formaldehyde is found in the urine or vesical irritability occurs. The prevailing opinion concerning this drug is that it is of no actual value in such conditions as anterior poliomyelitis, meningitis, cholecystitis, cholelithiasis, typhoid fever, and diseases of the respiratory tract, exerting an antiseptic effect only in situations where an acid reaction exists. A. G. Dumas (Jour. Kans. State Med. Soc., May, 1922).

While the drug has a very definite bactericidal action in the bladder, it has not been demonstrated that this applies also to the renal pelvis. Helmholz (Jour. Amer. Med. Assoc., July 22, 1922).

Intravenous injection of methenamine has been recommended by several observers for relieving **post-operative retention of urine**.

As a generally dependable though not infallible measure, both prophylactic and therapeutic, for **post-operative retention of urine** in gynecologic cases, the writer found intravenous injection of 40 per cent. methenamine solution useful. The desired result was obtained in 85 per cent. of his 65 cases. After the Wertheim radical operation it usually failed. Five c.c. (80 minims) at a dose should preferably not be exceeded, as larger amounts may increase to an unpleasant degree the strangury and tenesmus which follow the 5 c.c. dose as by-effects in a few cases. At times even hematuria might result; further, an eccholic action seems to be exerted by the drug in large doses in pregnant patients. F. Sieber (Monat. f. Geburts. u. Gyn., Oct., 1924).

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**HEXYLRESORCINOL.**—This compound, introduced in medicine by Veader Leonard (Jour. Amer. Med. Assoc., Dec. 20, 1924), results from the addition of 6 alkyl radicals to resorcinol, the bactericidal power of which is thereby increased by more than 15,000 per cent. Its phenol coefficient is 46.0.

**ADMINISTRATION.**—The crystals of the drug in enteric-coated capsules are administered for urinary antiseptics 3 times a day in doses of 0.33 to 1 or 2 Gm. (5 to 30 grains). In the preparation known as *caprokol* the drug is commercially available in elastic capsules each containing 0.15 Gm. ( $2\frac{1}{2}$  grains) in a 25 per cent. solution in olive oil. In children a  $2\frac{1}{2}$  per cent. solution in olive oil may be given as such.

**PHYSIOLOGICAL ACTION.**—Hexylresorcinol is asserted to be the most powerful germicide ever described as a non-toxic substance. Indeed, the toxicity of the alkyl resorcinols, as each additional carbon atom group was added, was found to decrease as their bactericidal properties increased. Five men were given over 45 Gm. each of normal hexylresorcinol over 6 weeks without any toxic effects or urinary tract irritation.

Hexylresorcinol retains its strong bactericidal action in urine of any reaction; sodium bicarbonate must not be combined with it. The bulk of each dose is excreted as an inert conjugate, otherwise much smaller doses could be used. Mild catharsis frequently attends its use at first.

**THERAPEUTICS.**—In urinary tract infections due to *Staphylococcus albus*, *S. aureus*, the streptococcus, and some strains of *B. pyocyaneus*, oral use of hexylresorcinol, without other treatment, has resulted in prompt and complete disinfection of the urinary tract, with consequent clearing of the urine and disappearance of symptoms. Colon bacillus infections have also cleared up completely under it, though, as described by Leonard (Jour. of Urol., Dec., 1924), this occurs only if the bacterial count in the urine is low; if it is high, the drug proves insufficient until the count has been brought down by local applications.

Hexylresorcinol is not claimed to exert any appreciable influence on infections which have already invaded the parenchyma of the kidney.

In the treatment of pyelitis in infants and children, W. J. Scott and Leonard (Amer. Jour. Dis. of Childr., Feb., 1926) have used initial doses of 0.1 Gm. ( $1\frac{1}{2}$  grains) in a 2.5 per cent. solution in olive oil, increased to 0.2 to 0.3 Gm. (3 to 5 grains), 3 times daily. A maximum of 0.6 Gm. (10 grains) thrice daily was given to young children for months without evidence of toxic action or gastrointestinal irritation. The fluid intake should *not* be increased and sodium bicarbonate should not be taken during the use of the drug. In adults, a chronic *B. coli* urinary infection could be permanently removed by continuous use of the drug for 60 to 90 days, in children, the time required seemed to be shorter. The results, in general, were favorable, and there was a striking improvement in the general health and nutrition of the children even long before any improvement in the local condition. It appears that hexylresorcinol is not contraindicated in nephritis.

S.

**HICCOUGH** (Singultus, Hiccup).—This symptom, which sometimes becomes extremely distressing, and may even end in death, is due, according to Bertier and other authorities, to a sudden contraction of the diaphragm, causing a sudden motion of the abdominal and thoracic walls, and accompanied by a coarse and inarticulate sound caused by the closing and sonorous vibration of the lips of the glottis. The diaphragmatic spasm is but one of the factors of the syndrome, which comprises other associated phenomena, glottic and gastric. There is a double nervous control of the act of hiccoughing: through the phrenic the diaphragm is made to contract; by means of the vagospinal nerves there are brought about the closure of the glottis, the contraction of the stomach, and the relaxation of the pyloric sphincter. A center co-ordinating these movements is supposed to exist in the neighborhood of the vital center and the center of vomiting. Numerous centripetal paths bring the hiccough center into relation with numerous peripheral sources of irritation.

Hiccough is sometimes preceded by a sort of aura, a sense of epigastric tension. Sometimes diaphragmatic spasm is so violent as to cause a synchronous raising

of the shoulders, limbs, and trunk, rapidly producing fatigue if the attack is prolonged. In other cases the glottic element is the principal one, producing an intense sound like the bark of a dog (a case being reported in which the sound was heard at a distance of three-quarters of a mile). Ordinarily the spasms have a rate of 6 to 15 per minute, but in severe cases there are as many as 60 to 80. They have already been observed in one case synchronous with the cardiac pulsations. Generally hiccough stops during the night; sometimes it persists. In severe cases hiccough causes a considerable amount of functional disturbance: anxious respiration, cyanosis, difficulty of deglutition, and serious impairment of nutrition. In the course of diaphragmatic pleurisy it causes intense pain and insomnia. Speech is sometimes impossible. At times hiccough relieves the distress of dyspeptics by causing eructation of gas. Ordinary attacks of dyspeptic hiccough last a few minutes; those due to inflammation of the pleura or peritoneum may persist for hours or days. Certain hysterical cases have lasted for twenty to thirty years.

#### ETIOLOGY AND PATHOGENESIS.

—The irritation of the problematic center or centers is traceable clinically to the domain of the vagus (foreign bodies in the lung, pleurisy, affections of the liver, stomach, intestines, peritoneum, esophagus, pharynx), of other visceral nerves (pregnancy, diseases of the prostate, kidneys, bladder, uterus), or the nerves of general sensibility (exposure to cold). Besides these reflex causes of hiccough there are direct central forms of stimulation of the center controlling this act. Thus, it may be due to imagination (hysteria, imitation, epidemicity), to toxic products (uremia, tobacco, alcohol), and to anoxemia (agony, severe hemorrhage). The irritation may affect the centrifugal limb of the reflex arc (luxations of the cervical vertebræ, tumor of the mediastinum, aneurism of the aorta, pericarditis, diaphragmatic pleurisy, wounds of the diaphragm, splenomegaly, and perisplenitis). Hiccough has been observed in the following disturbances: Diseases of the stomach; liquids too hot or too cold, unchewed food, carbonated liquids, in-

digestion; it may be a troublesome accompaniment of cancer, ulcer, and hyperchlorhydria. In nurslings it indicates an overloaded stomach.

In healthy infants which have been fed too much, or irregularly, hiccough indicates at least that a sufficient quantity has been ingested to reach the limit of the digestive capacity of the stomach. Victor Thevennet (*Lyon méd.*, Aug. 27, 1905).

The writer refers to a primipara who in the last 2 months of gestation felt peculiar shocks in the abdomen which succeeded one another more or less rapidly over a period of 5 to 10 minutes. They were quite unlike ordinary fetal movements. The hand of the author was able to feel them. Circulatory troubles of mother and fetus could be excluded as could also uterine contractions. The fetal heart sounds were as if interrupted by the shocks. The child, otherwise normal, had hiccough after delivery. Chapuis (*Revue Méd. de la Suisse Rom.*, Jan.-Feb., 1917).

Affections of the pharynx: aphthæ, abscess, esophageal spasm due to benign or malignant stricture may also act as a cause. This applies also to the following disorders: Diseases of the peritoneum: every time the peritoneum is irritated hiccough is apt to arise; it is less constant in the localized varieties. Intestinal disorders, including dysentery, lumbricoides. Diseases of the liver. Diseases of the spleen, most frequently hypertrophy. Genitourinary disorders, above all; affections of the bladder. Uterine disorders. Pregnancy: in this case hiccough is due to toxemia, like vomiting. Abdominal wounds. Diseases of the respiratory organs, particularly diaphragmatic pleurisy and pneumonia. In the former it is the source of agonizing pain. It is seen in subphrenic abscess. In pneumonia it occurs on the fifth or sixth day and is ordinarily very violent. Mediastinal compression. Pericarditis, in which it is a bad symptom. Exposure to cold. Affections of the peripheral nerves, as in sciatica. Spinal disorders, as displacement of cervical vertebræ.

Hiccough may also be of central origin;



prominent in this connection is hysteria. Boerhaave reported an epidemic in Haarlem. These cases may be easily differentiated from those of symptomatic origin. In the former the glottic phenomenon is the most marked, and the sound produced is intense. The prognosis is good, as regards life, but interference with sleep and nutrition may cause general debility. Emotion occurs as a cause in neuropathic subjects, and sometimes in the course of laughing or crying, when it is really a sobbing. Chorea and epilepsy, intoxications, lead colic, nicotinism, alcoholism, and autointoxications, as uremia, are other causes of hiccough.

Of the hiccough that occurs in the course of infections that of typhoid fever has been most studied. It appears late, most frequently in some epidemics, at first is intermittent and then incessant, sometimes accompanied by biliary vomiting, preventing sleep, interfering with speech and swallowing, and disappearing at the end of a few days. It has been attributed to various causes: abdominal distention, splenic hypertrophy, ulceration of esophagus, and most recently to the action of the typhoid toxins upon the bulbar center. Hiccough is also seen in scarlatina, scurvy, yellow fever, cholera, and hydrophobia, and also in cachexia, hemorrhages, death agony, bulbar diseases, and cerebral affections. In diagnosis hiccough may be easily distinguished from pharyngeal and laryngeal spasms, yawning, and aerophagia (Bertier).

In a case seen by Green, hiccough persisting 6 months was traced at autopsy to a small tumor in a pulmonary hilus, which had probably pressed on the phrenic nerve. Removal of impacted ear wax, in a case recorded by O'Reilly, was followed by cessation of an obstinate hiccough.

**TREATMENT.**—The physician is not called in, as a rule, until all the usual family resources—tickling of the pharynx, the swallowing of ice, salt, lemon-juice, vinegar, strong spirituous liquors; holding the breath a minute or two; traction on the tongue for several minutes—have been tried and proved useless. To these procedures, which sometimes prove effectual by causing inhibition of the motor phenomena, might be added: **Compression of the auditory meati with extension of the**

**head, chloroform compresses on the epigastrium, epigastric ether pulverizations, raising of the hyoid bone, drinking slowly while pinching the nose, sinapisms, pharyngeal irrigations with cold water, compression of the fists, compression of the cubital region, compression of the ball of the thumb with the little finger, a little salt or sugar placed on the tongue, and thrusting the tongue systematically out of the mouth; increasing the oxidation of the blood by means of 40 to 50 rapid and deep respirations.** Among the more difficult practices may be mentioned: **Catheterization of the esophagus, tetanizing galvanization of the esophagus.**

**Lying face down** on the floor recommended as a remedy for hiccough. (Often it is well also to give 2 Gm. (30 grains) of **sodium bromide** a day after meals, and a tablespoonful every 2 hours, 5 or 6 times a day, of a suspension of 10 Gm. (150 grains) of **bismuth subcarbonate** and 20 Gm. (5 drams) of acacia in 300 c.c. (10 ounces) of distilled water. G. Leven (Presse méd., Dec. 29, 1920).

In a man aged 51 who had had hiccough for 24 hours, the writer, in passing a tube into the stomach, noticed a condition of esophageal spasm, which disappeared as a result of the procedure, the hiccough ceasing likewise. He quotes Fulde to the effect that a **stomach tube left *in situ*** for a few minutes is one of the best remedies for hiccough. Cristol (Presse méd., Feb. 11, 1922).

The author recommends the ancient method of Eryximachos, that of inducing the sneezing reflex by **irritation of the nasal mucosa with a feather or a piece of paper.** Vomiting also cures hiccup. Both methods act by stretching the diaphragm. Hishikawa (Schweiz. med. Woch., Apr. 10, 1924).

**Mechanical interference with movements of diaphragm; forcible manual compression of the diaphragm, forced expiration or inspiration, abdominal bandage, and suspension of respiration.** A suggestive method is that of Kannegiesser, which consists in administering **effervescing fluids to**

dilate the stomach, *e.g.*, 5 Gm. (75 grains) each of citric acid and sodium bicarbonate in separate glasses in solution. Arrest of the diaphragmatic contractions may also be carried out by compressing the abdomen with the patient's thighs. Donnelly recommends having the patient hang with arms extended from a beam or pole and, with the abdominal muscles tense, hold his breath as long as possible. If there is flatus, intestinal irrigation with soapsuds and turpentine may be effective.

Good results claimed from placing the thumbs below the costal arches and making outward pressure, stretching the diaphragm. Heermann (Deut. med. Woch., June 23, 1922).

Cessation of hiccough observed in a considerable proportion of cases upon intramuscular injection of 25 or 30 minims (1.6 to 2 c.c.) of ether. The writer used the procedure more particularly in post-operative hiccough. It may be repeated 1 or more times at several hours' interval. C. L. Gibson (Jour. Amer. Med. Assoc., Feb. 10, 1923).

Of value at times have been tincture of capsicum, Hoffmann's anodyne, anesthesin, chloretone, validol and, in particular, benzyl benzoate, 40 to 60 drops, well diluted, at 2- or 3-hour intervals. In some aggravated cases, direct galvanization to the neck alone gave relief. D'Alessandro grasps the carotid sheath with the thumb and forefinger, at the middle of the anterior border of the sternomastoid; the sheath is compressed tightly for about 1 minute, the hiccough usually ceasing at once. Friedenwald and Levy (Med. Jour. and Rec., Feb. 6, 1924).

Ten drops of a 5 per cent. potassium iodide solution twice daily recommended for hiccough. Gause (Deut. med. Woch., Mar. 13, 1925).

In hysterical cases valerian and any of the above methods, to influence autosuggestion in addition to their reflex effects, often do good. If not, hypnotism, may prove effectual. Lavage of the stomach is sometimes effective in these cases, especially if it has never been used before on them. Musk is sometimes helpful.

Postprandial hiccough is often chronic and requires regulation of the diet, but a stubborn gastric case is best relieved by means of an emetic. Such cases are often reflex, though occasionally due to autointoxication. The various disorders of digestive tract enumerated under ETIOLOGY should be sought in persistent cases.

When a baby begins to hiccough, it is often given granulated sugar, and many times with good result; or a teaspoonful of plain water, or of water with anise or peppermint, any of which may succeed. An older child may be made to hold his breath for a portion of a minute, or to drink rapidly a glass of water, either of which methods may hold the diaphragm quiet long enough to overcome the tendency to spasm. Adults can hold the breath longer, and frequently thus check the hiccough.

Sometimes provoking sneezing will stop hiccough. Also, if a patient is well and strong, any slow muscular effort, as lifting a weight, or especially pulling the body several times up by the hands holding onto any trapeze arrangement, is often successful. If not, and the stomach is overloaded, an emetic, as ipecac, may be administered. Editorial (Jour. Amer. Med. Assoc., July 29, 1911).

Inveterate case stopped when the eyeballs were compressed. Aquino (Semana Med., Apr. 19, 1917).

Obstinate hiccough cured by 1 dose of quinine, 10 grains (0.6 Gm.). A morsel of sugar dipped in vinegar stops it. (Amer. Med., Oct., 1917).

Case of 13 months' duration, associated with hysterical monoplegia, cured by suggestion during intoxication with bromides. Hurst (Seale Hayne Neurol. Studies, Sept., 1918).

The hiccough brought on by uremia is best relieved by hot-air baths. In some cases this may be assisted by means of pilocarpine hydrochloride,  $\frac{1}{4}$  grain (0.016 Gm.) being administered hypodermically.

As emergency remedy, morphine acts, as a rule, only temporarily; this applies also to atropine, which often proves ineffectual. Gelsemium has been praised, but the

preparations available in the shops are often defective in strength and quality.

Hiccough is a not uncommon complication of convalescence in severe sunstroke cases. In 3 such cases **gelsemium** gave immediate and striking benefit. A thoroughly trustworthy fluidextract must be used. The initial dose given by the writer is generally 2 minims (0.12 c.c.). In some cases this is sufficient to relieve, but, as a rule, it has to be increased. W. L. Bauer (N. Y. Med. Jour., May 6, 1911).

**Chloral hydrate** and the **bromides** have been highly praised by some and found ineffectual by others. But inasmuch as the numerous possible causes of the symptom are often obscure, a remedy capable of good in one case might prove ineffectual in another. **Scopolamine hydrobromide**,  $\frac{1}{200}$  grain (0.0003 Gm.) orally or hypodermically, repeated if necessary, has been lauded. This applies also to **nitroglycerine** in doses of  $\frac{1}{400}$  grain (0.0006 Gm.) repeated in one or two hours as needed. **Adrenalin** has been recommended. **Drainage of the gall-bladder** is sometimes necessary.

Case of obstinate hiccough in a patient suffering from renal colic in which large doses of the usual drugs and gastric lavage failed. On the eleventh day **adrenalin** proved promptly effective. The patient took 10 drops of the 1:1000 solution; at once the hiccough became milder and less frequent, and, upon repeating the dose half an hour later, the symptom completely and permanently disappeared. J. Ségal (N. Y. Med. Jour., from Jour. des praticiens, Aug. 23, 1913).

A prompt remedy in some instances, is **amyl nitrite**, a few drops being inhaled at intervals, increasing in length as the hiccoughs become fewer. **Chloroform** inhalations, sometimes to the stage of general anesthesia, may become necessary. Post-operative hiccough is best prevented by giving only a nitrogen-free diet or water.

Case in which all the usual methods brought no result. The writer then gave 10 drops of a saturated solution of **menthol in spiritus vini rect.**, in a little hot water. This was to be

repeated every hour if necessary. With the first dose relief was experienced, and after 4 doses in the first 24 hours there was no recurrence. Mead (Med. Record, Jan. 10, 1914).

## EPIDEMIC HICCOUGH.

This has been attributed to some specific infection. Lhermitte (Presse méd., Dec. 13, 1920) considers this disease one of the numerous manifestations of epidemic encephalitis. The first observation of febrile epidemic hiccough was made by Economo as part of an epidemic of encephalitis—not the original outbreak, but the myoclonic epidemic of the winter of 1919-1920. So far as Austria was concerned the hiccough antedated the encephalitis. The latter exhibited extensive polyclonic manifestations, including spasms of the diaphragm, which recalled the original outbreak of isolated hiccough. Economo was nevertheless very conservative in connecting the 2 manifestations—the idiopathic and symptomatic hiccough. The same association of the 2 has been seen in Paris and Switzerland and the conclusion is hardly escapable that idiopathic hiccough may be a monosymptomatic encephalitis.

P. Gautier (Revue Méd. de la Suisse Rom., May, 1920) observed 5 cases of intense spasmodic hiccough in Geneva, coming on suddenly, persisting for from 2 to 4 days, and then disappearing with equal suddenness, without the treatment having much effect. The patients were 4 men of 30 to 45, and 1 woman of 46. The lumbar puncture fluid was found practically normal in the 1 case examined.

In some cases the hiccough appears to be accompanied by mild catarrhal symptoms of influenzal origin. A patient examined by Jenkins (Lancet, Jan. 22, 1921) had a profuse yellow nasal secretion of thin consistency. Besides staphylococcus, a very minute bacillus, indistinguishable from *B. influenzae*, was found in culture plates. The organism was Gram-negative but did not take any of the ordinary stains well. A fairly strong solution of carbolfuchsin was necessary in order to obtain a well stained film. The colonies and films from subcultures did not differ from those of the original culture. No growth occurred on plain nutrient agar.

**TREATMENT.**—Any of the measures described above may be employed besides treatment of the causative disorder. Macht (Med. Rec., July 24, 1920) found **benzyl benzoate** invaluable in persistent hiccough of both adults and children. This is best given in a 20 per cent. solution in alcohol, the dose being from 20 to 40 drops in water or milk. To children the solution can be given in sugar, water or milk.

**HOLOCAINE** (amidine) is a condensation product of paraphenetidin and acetphenetidin. It is always employed in the form of the hydrochloride, which occurs in small, colorless crystals, neutral or feebly alkaline. It dissolves in 50 parts of water (more easily in boiling than in cold water) and is freely soluble in alcohol. Its solution in water is clear and colorless, except if boiled in a glass vessel, when turbidity develops, owing to liberation of a small amount of alkali from the glass, which unites with the HCl, thereby causing precipitation of the insoluble uncombined holocaine. To avoid turbidity in the preparation of the solution, a porcelain vessel may be used. Bottles in which holocaine solution is to be kept should previously have been boiled in dilute hydrochloric acid and rinsed in distilled water. Holocaine solutions keep well. The drug is not official.

**PHYSIOLOGICAL ACTION.**—Holocaine is a local anesthetic agent, like cocaine, and in addition possesses some antiseptic power. Its anesthetic action, which is exerted more rapidly than that of cocaine, is preceded by a distinct burning sensation, manifest whether the drug be used in the eye or injected into the skin. The drug also tends to produce redness of the tissues with which it is brought into contact. Unlike cocaine, it does not dilate the pupil or diminish intraocular tension, and it exerts less, if any, drying effect on the cornea.

As for its systemic action, holocaine presents no advantage over cocaine. According to Zunz, it is, in fact, more toxic than cocaine, and resembles strychnine in its action, death in experimental poisoning being due to "cramp asphyxia." Braun points out that only 0.01 Gm. ( $\frac{1}{8}$  grain) of holocaine is required to bring on convul-

sions in a rabbit, and advises caution in the use of the drug as a local anesthetic.

**THERAPEUTICS.**—Holocaine is used as a local anesthetic chiefly in ophthalmic surgery. The solution of the hydrochloride generally employed is of 1 or 2 per cent. strength. Instillation of 1 or 2 drops of this solution brings on analgesia in less than one minute; and if the instillation is repeated after an interval of forty seconds, absolute corneal anesthesia will supervene half a minute later. This condition will persist for ten minutes, and the analgesia will continue for five minutes after the return of tactile sensibility (Zunz). By repeated instillations, the anesthetic effect can be kept up as long as desired. Where the anterior chamber of the eye is opened, the drug will act as quickly on the iris and ciliary body as it does on the cornea. The anesthesia produced by holocaine equals in intensity that of cocaine, while not lasting quite as long. Some surgeons prefer it to cocaine in operative work on the eye. According to Derby, it causes a greater degree of insensibility of the iris than cocaine. De Schweinitz, in making observations of the intraocular tension with Schiötz's tonometer, instills a 2 per cent. solution of holocaine three times at three-minute intervals. The drug is also useful for purely analgesic purposes in a variety of ocular affections, such as **vernal conjunctivitis**, **phlyctenular** or **relapsing traumatic keratitis**, **glaucoma**, and especially in **corneal ulcer**, where holocaine, applied directly to the ulcerated surface, exerts a favorable germicidal effect, in addition to relieving photophobia (Derby). Jackson has advised the use of holocaine as local anesthetic in the removal of **foreign bodies** from the eye, on the ground that it will protect the cornea from infection through its antiseptic action.

The vasodilating tendency of holocaine can be overcome, and its anesthetic power slightly increased, by adding to the solution a minute amount of epinephrin.

Holocaine should not be used for anesthesia by intra- or sub-cutaneous injection, its toxicity being far in excess of that of agents such as novocaine, stovaine, betacaine, etc. Nor should it be used internally. From instillation into the eye in

customary amounts, however, little or no danger of a toxic action seems to exist.

S.

**HOMATROPINE.**—When atropine or hyoscyamine is heated with baryta water, the alkaloid is decomposed into tropine (another alkaloid) and tropic acid. Tropine, mandelic (oxytoluic) acid, and dilute hydrochloric acid are then mixed, and gentle heat is applied for a prolonged period; when the mixture has evaporated down, the alkaloid homatropine crystallizes out in deliquescent, colorless, prismatic crystals. Homatropine [ $C_{16}H_{21}NO_3$ ] is freely soluble in alcohol, ether, chloroform, and oil, but only slightly in water. Its salts with hydrochloric, hydrobromic, and sulphuric acids are white and crystallize well.

#### PREPARATIONS AND DOSE.—

Homatropine is official only in the form of the hydrobromide (*homatropinæ hydrobromidum*), which occurs in small, white, lustrous crystals, soluble in 6 parts of water and in 33 parts of alcohol. A solution of homatropine hydrobromide in water is quite permanent. Though this alkaloid is generally used locally, it may also be given internally, in doses of  $\frac{1}{2}$  to  $\frac{1}{60}$  grain (0.0005 to 0.001 Gm.).

In addition to aqueous solutions of the hydrobromide, a 2 per cent. solution of the uncombined alkaloid in castor oil has been used for ocular instillation. Disks of glycerogelatin, each weighing about  $\frac{1}{60}$  grain and containing  $\frac{1}{400}$  grain of homatropine hydrobromide, are recognized in the British Pharmacopœia (*lamellæ homatropinæ*); they are likewise intended for use in the eye.

**PHYSIOLOGICAL ACTION.**—The physiological action of homatropine resembles that of atropine. It dilates the pupil very rapidly and energetically, but the effect passes off in twenty-four to forty-eight hours, whereas the mydriasis of atropine lasts for ten to fourteen days, and that of hyoscyamine for eight or nine days. Repeated instillations of homatropine solution (1 or 2 per cent.) may cause a lowering of the pulse rate, which is, however, only temporary. Slight hyperemia of the conjunctiva often attends its use, but this generally disappears by the

time the full effect of the drug has been developed (Jackson). Instillations of strong solutions (4 to 5 per cent.) induce a burning sensation on the conjunctiva, and if a large amount has been used, the bitter taste of the alkaloid becomes perceptible, but without the dryness of the pharynx which follows the use of atropine. The action of homatropine on the circulation differs from that of atropine in that the former lessens the pulse rate—probably through vagus stimulation—and lowers the arterial pressure. Unlike atropine, again, it does not induce a skin eruption.

#### POISONING BY HOMATROPINE.—

No fatal cases of poisoning have been reported from the medicinal use of the remedy in question. This, no doubt, results from the almost exclusive use of homatropine by instillation in ophthalmology. According to Jackson, complaint of a bitter taste is the only common extraocular symptom noted after homatropine instillation. De Schweinitz and Hare, in experiments on frogs, found that this drug in large doses first alters the respiration to the Cheyne-Stokes rhythm, then arrests it completely; this is succeeded by a tetanic condition and later by general paralysis, the peripheral nerves and muscles remaining, however, untouched. The cardiac function is retarded and pulse rate diminished, but the respiratory paralysis is the cause of ultimate death.

Case of homatropine idiosyncrasy in a neurotic patient suffering from eye-strain. Homatropine hydrobromide was used, 2 drops of a 10 grain (0.65 Gm.) to the ounce (30 c.c.) solution being instilled into each eye at intervals of fifteen minutes. The solution had been freshly prepared and was used upon other patients without bad effect. Cycloplegia was produced within forty-five minutes, the patient becoming quiet and subdued. During the shadow test she became pale, dizzy, and fainted. This soon passed off and was succeeded by mild delirium and incoherent speech, which persisted for about twenty-four hours. At the end of five days the mydriasis disappeared. S. H. Brown (*Annals of Ophthal.*, April, 1906).

Case of a man 30 years of age who was refracted without exhibiting any symptoms other than a flushing of the face. The solution used had been freshly prepared in the ordinary strength of  $\frac{1}{2}$  grain (0.032 Gm.) to  $\frac{1}{2}$  dram (2 c.c.), and 1 drop instilled every ten minutes for one hour. After leaving the office he started for home, but had not reached there some time after. After a careful search he was found sitting on a curbstone several squares away from the office and in an opposite direction to his home. Upon being taken home he said that he had had no idea as to the proper direction to take and had wandered aimlessly about the street as long as his weakened legs would carry him, and then sat down and gone to sleep. After rest in bed in a darkened, quiet room he soon recovered his natural poise. A second case was that of a girl 12 years old who while the drops were being put in her eyes, complained of being tired and wanted to go to sleep. When she walked into the office her mother had to hold her up. She became quite violent, striking at anyone who came near. Her speech was confused and incoherent, with silly laughter, picking at imaginary objects, great restlessness, etc. After waiting two hours she was taken home and put to bed for some hours. E. G. Whinna (Homeo. Eye, Ear, and Throat Jour., Aug., 1909).

A physician, aged 50 and in excellent health, had a drop of a weak solution of cocaine, followed by a wafer containing cocaine and homatropine, of each,  $\frac{1}{100}$  grain (0.0013 Gm.), put into his eyes by an oculist one morning. On the afternoon of the next day a well-circumscribed, bright-red, raised, edematous patch appeared on the penis and scrotum. It was very itchy and tinglingly hot. Next day a red patch appeared on the dorsum of the right foot. Two days later there appeared two red papular patches over the front of each thigh. The feces were now dry. The small toes of the right

foot became red, swollen, hot, and itchy, and the sputum was noticed to be a little more viscid than normal. The dilatation of the pupils had by this time almost disappeared. Six days after the medication, the eruption was rapidly decreasing, but the skin was still dry and hot, and for two days the tongue had been rough as felt against the palate; it tingled slightly, and there was a sweetish taste in the mouth.

The disturbances were evidently due to the homatropine, as they occurred coincidentally with the dilatation of the pupils and subsided with their contraction; they were vasodilatory, and therefore in accordance with the eruptions of belladonna and atropine. D. W. Montgomery (Calif. State Jour. of Med., June, 1913).

**Treatment of Poisoning by Homatropine.**—The treatment of poisoning by this remedy is similar to that of atropine poisoning. If the drug has been taken internally, the stomach is to be evacuated by **emetics** and the **stomach-tube**. **Tannic acid** and **animal charcoal** should then be administered, and **emetics** again given, followed by **castor oil**. **Artificial respiration**, **heat**, **stimulants**, and **hypodermics of strychnine** are useful to support the respiration. **Morphine** may be given carefully as a physiological antidote.

Case of a young lady of 26 who had had homatropine drops instilled previously without ill effect. A 2 per cent. solution of the hydrobromide was ordered, 2 drops to be put in each eye every five minutes for half an hour, beginning one hour before the time of the appointment. After 2 instillations the patient felt dizzy and faint and twenty minutes later "collapsed." She was found highly nervous, complaining of dizziness and fullness of the head, with face congested, skin hot and dry, pupils dilated, and mucous membrane of mouth and throat so parched that swallowing was almost impossible; pulse 130 and weak; respirations rapid. The patient soon lapsed into unconsciousness. **Strychnine**, gr.  $\frac{1}{320}$

(0.002 Gm.), was given, followed half an hour later by gr.  $\frac{1}{80}$  (0.001 Gm.). Tincture of opium,  $\text{m} \times$  (0.6 c.c.), was administered as an antidote, and repeated later; also **strong black coffee**; **cold compresses to the head**, and **hot-water bags to the feet**. These measures were followed by an **enema**, and the patient's condition improved considerably. Later the pulse became weak and the finger-tips cyanotic. Gradually the symptoms moderated and a busy, talkative delirium supervened. Next morning the patient was quite rational, but depressed and nauseated; the urine was less in quantity and dark (the patient was menstruating). The patient complained of extreme weakness and a faint feeling about the heart for several days. The pupils remained dilated one week after the instillation of  $\frac{1}{4}$  grain (0.013 Gm.) of homatropine. J. R. S. Shannon (N. Y. State Jour. of Med., June, 1909).

The local effects of homatropine in the eye can be readily overcome when this is desired—*e.g.*, in a case of glaucoma where the drug has been used by mistake—by instillation of a solution of eserine.

**THERAPEUTICS.**—Homatropine is almost exclusively used by ophthalmologists to dilate the pupils, as well as, sometimes, to paralyze the muscle of accommodation for the purpose of correcting anomalies of refraction. Mere pupillary dilatation, such as is required in the examination of the crystalline lens for **cataract**, is more easily secured with homatropine than paralysis of the ciliary muscle. For the latter purpose, good results are obtained only by repeated instillation (at the upper border of the cornea—Jackson) of 1 drop of a 4 grain (0.26 Gm.) to the ounce (30 c.c.) solution every five or ten minutes or the same amount of an 8 or 16 grain (0.5 or 1.04 Gm.) to the ounce (30 c.c.) solution every fifteen minutes for an hour and a half. After this period, forty minutes more should be allowed to elapse before the examination for refraction is made (De Schweinitz). The paralysis of accommodation resulting from such use of homatropine disappears

in about forty-eight hours. For therapeutic uses in ophthalmology, atropine is generally used, although for incipient cataract Risley prefers homatropine, especially where there is discomfort without increased ocular tension.

Among 1000 patients in whom homatropine was used there were 22 where incomplete paralysis of accommodation was suspected. These were examined under a stronger mydriatic, and of the 44 eyes only 6 showed a higher refractive error than had been noted under homatropine. Some samples of homatropine are irritating. The amount of the drug commonly employed—from  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.01 to 0.016 Gm.)—rarely produces constitutional symptoms. Edward Jackson (Annals of Ophthal., Jan., 1901).

After completing an examination under homatropine, the author puts in the eyes a 1 per cent. solution of eserine sulphate, combined with 2 per cent. pilocarpine hydrochloride. The pupil usually returns to its normal size in about one hour if this solution is used three times at twenty-minute intervals, and the accommodation is restored within twelve hours. P. A. Callan (Merck's Archives, Nov., 1906).

Where **foreign bodies** have been impacted in the **cornea** for several days, with ulceration and some injection of the ocular conjunctiva and possible scleral inflammation, a few drops of homatropine solution remove the symptoms in twenty-four to forty-eight hours, and the rapid restoration of accommodation is most gratifying to the patient. In **epi-scleritis**, **scleritis**, and mild **iritis**, paralysis of the accommodation is of great inconvenience to the patient, yet the pupil must be dilated. A few drops of homatropine will yield a cure in two or three days and accommodation will return in four or five days. In **iritis** and **iridocyclitis** in the elderly, with increased tension, where a mydriatic is often poorly borne, homatropine is indicated. A change

to a miotic then brings its good results much more quickly than if another drug has been used. Emerson (Ophthalmic Record, Sept., 1910).

Five cases in which small amounts of homatropine in the eyes for purposes of **refraction** was followed by glaucoma. This occurrence is rare—not over once in 10,000—cases—but steps should always be taken to prevent it. Three of the 5 cases suffered permanent damage to vision, while the other 2 were cured by the immediate use of physostigmine. The latter agent should be used as a routine following the employment of such mydriatics as homatropine, excepting in the case of young children. For every patient who has had homatropine, there should be prescribed from 10 to 15 drops of a solution containing 1 grain of physostigmine to the ounce. The patient should use 1 drop, 3 times daily, until the pupil has returned to normal and sight for near objects is restored. H. Gifford (Jour. Amer. Med. Assoc., July 8, 1916).

In elderly patients who have lost practically all their accommodation the writer uses euphthalmin and cocaine, 1 per cent. of each, for refraction, and if these do not dilate a rigid pupil, homatropine and cocaine. Most of his cases are refracted under homatropine, which he uses in adult patients at any age while accommodation remains. The most important time for its employment is after 40. C. D. Westcott (Amer. Jour. of Ophth., Mar., 1923).

W. and S.

**HYDRASTIS.**—*Hydrastis Canadensis*, the dried rhizome and roots of which constitute the official *Hydrastis*, U. S. P., is a small, perennial herb, termed in the vernacular golden seal, yellow puccoon, yellow root, etc. In recent years its growing scarcity has resulted in both a marked increase in price and frequent sophistication of the crude drug.

Hydrastis contains two principal

alkaloids, *hydrastine* and *berberine*; a third alkaloid, *canadine*, is found only in very small amount. Although berberine is found in greater quantity than hydrastine, the latter is the characteristic alkaloid. The percentage of it present in the crude drug varies from about 2 to 4.5. Berberine is peculiar among alkaloids as a class in having a yellow color, and occurs in many other plants besides hydrastis, including *Berberis aquifolium* (Oregon grape), *B. vulgaris* (barberry), *Coptis trifolia* (goldthread), *Jateorrhiza palmata* (calumba), *Xanthoxylum Americanum* (prickly ash), etc.

Hydrastinine is an artificial alkaloid produced from hydrastine by oxidation with potassium permanganate or nitric acid. Hydrastine and hydrastinine are closely allied chemically to narcotine and cotarnine, the former an opium alkaloid.

#### PREPARATIONS AND DOSE.—

*Hydrastis*, U. S. P., the crude drug, of yellowish to grayish-brown color, is officially required to contain 2.5 per cent. of the ether-soluble alkaloids of hydrastis. Dose, 30 grains (2 Gm.).

*Fluidextractum hydrastis*, U. S. P. (fluidextract of hydrastis), prepared by maceration and percolation of the powdered drug with a 10 per cent. mixture of glycerin with equal parts of alcohol and water. It is required to contain 2 Gm. of ether-soluble alkaloids in every 100 c.c. Dose, 30 minims (2 c.c.).

*Glyceritum hydrastis*, U. S. P. IX (glycerite of hydrastis; aqueous fluidextract of hydrastis), made by maceration and percolation in a mixture of glycerin, alcohol, and water containing over 50 per cent. of the first-named fluid. The preparation forms



a clear mixture with water, and each c.c. of it contains the water-soluble constituents of 1 Gm. of the crude drug. Dose, 30 minims (2 c.c.).

*Tinctura hydrastis*, N. F. (tincture of hydrastis), a 20 per cent. preparation, required to contain 0.4 Gm. of alkaloids in every 100 c.c. Dose, 1 to 2 fluidrams (4 to 8 c.c.).

*Hydrastina*, U. S. P. IX (hydrastine)  $[C_{21}H_{21}NO_6]$ , occurring in white prismatic crystals, bitter to the taste and permanent in the air. It is practically insoluble in water, moderately soluble in ether and cold alcohol, and easily soluble in chloroform, benzene, and warm alcohol. Dose,  $\frac{1}{5}$  grain (0.012 Gm.).

*Hydrastininae hydrochloridum*, U. S. P. IX (hydrastinine hydrochloride)  $[C_{11}H_{11}NO_2.HCl + aq.]$ , occurring in light-yellowish needles or a crystalline powder, with a bitter taste. It is freely soluble in water and alcohol, but dissolves only sparingly in chloroform and ether. Watery solutions of it, especially when very dilute, exhibit a blue fluorescence. Dose,  $\frac{1}{2}$  to 1 grain (0.03 to 0.06 Gm.).

*Hydrastinae hydrochloridum*, N. F. (hydrastine hydrochloride)  $[C_{21}H_{21}NO_6.HCl + aq.]$ , occurring as a white, amorphous powder, soluble in water. Dose,  $\frac{1}{6}$  to  $\frac{1}{2}$  grain (0.01 to 0.03 Gm.).

*Liquor hydrastinae compositus*, N. F. (colorless hydrastine solution), with alkaline chlorides. Dose, 1 fluidram (4 c.c.).

*Mistura rhei alkalina*, N. F. (alkaline mixture of rhubarb), containing rhubarb and hydrastis in small amounts in a flavored, alkaline menstruum. Dose, 1 fluidram (4 c.c.).

The following unofficial preparations of hydrastis are sometimes used:—

Berberine ("hydrastia") hydrochloride  $[C_{20}H_{17}NO_4.HCl + 2H_2O]$ , occurring in bright-yellow crystals or as an amorphous powder, with a strongly bitter taste. It is soluble in 300 parts of cold water, more soluble in hot water, and slightly soluble in alcohol. Dose  $\frac{1}{2}$  to 5 grains (0.03 to 0.3 Gm.).

Hydrastin, a dark-brown resinous extract from the crude drug, containing a mixture of the alkaloids. Dose, 3 to 10 grains (0.2 to 0.6 Gm.).

**MODES OF ADMINISTRATION.**—The fluidextract is the preparation generally employed for internal administration. Its taste may be disguised in some such mixture as the following:

R *Fluidextracti hydrastis*,

*Aquæ aurantii florum*,

*Syrupi cinnamomi*

(N. F.) ..... ʒiiss (10 c.c.).

M. Sig.: Teaspoonful every two hours.

When given as a bitter tonic hydrastis should be ordered taken before meals.

Adolphus recommends a combination of hydrastis with nux vomica, taraxacum, and podophyllum. Debove, Pouchet, and Sallard use the following mixture in metrorrhagia:—

R *Tinctura hydrastis* ..... ʒiiss (10 c.c.).

*Tinctura hamamelidis* .. ʒv (20 c.c.).

*Tinctura viburni pruni-*

*folii* ..... ℥L (3 c.c.).

M. Sig.: Teaspoonful every two hours in a half-glassful of mint infusion.

Hydrastine may be given in pills or cachets, or, in the form of the hydrochloride, in solution.

Hydrastinine hydrochloride is often administered hypodermically, in order to secure prompt hemostatic effects. The following combination has been prescribed in a pill (Debove):—

**R** *Hydrastininæ hydrochloridi* ..... gr. xv (1 Gm.).  
*Acidi gallici* ..... gr. lxxv (5 Gm.).  
*Extracti ergotæ aquosi* ..... 3j (4 Gm.).

M. Ft. in pil. no. L.

Sig.: One pill every fifteen minutes up to 4 as a minimum and 12 as maximum.

### PHYSIOLOGICAL ACTION.—

Taken internally, hydrastis acts as a bitter, increasing the appetite and promoting the secretion of saliva and gastric juice. It has been credited with cholagogue properties, and is believed also to increase the secretions of the intestinal glands. These effects are due to the berberine it contains.

There is little, if any, evidence of a general action on the nervous and circulatory systems after ingestion of ordinary doses of hydrastis. The effects succeeding absorption of toxic doses are essentially those of hydrastine, berberine being relatively inert. The primary effect of *hydrastine* is exaggerated reflex irritability, due to excitation of the spinal cord, followed, if the amount given be large enough, by convulsions of the strychnine type. These are followed by general motor paralysis, ascribed by Cerna to an action not only on the spinal cord, but on the peripheral motor nerve-structures and the muscles themselves. As regards the effects of hydrastine on the circulation, some degree of uncertainty still prevails. The majority of observers aver that small doses, *i.e.*, therapeutic doses, cause a rise in blood-pressure, due to contraction of the vessels (central, according to Cushny) and perhaps in part to acceleration of the heart beat. Large, *i.e.*, toxic, doses are well known, on the other hand, to produce a fall of blood-pressure by depressing the heart and either directly or indirectly

(through the vasomotor center) removing vascular tone. According to Cerna, hydrastine tends to abolish the irritability of muscular tissue in general. The respiratory rate is at first increased, then diminished, by it; in fatal poisoning, death takes place from respiratory failure. Locally applied, hydrastine exerts a slight anesthetic action. According to Kehrer, it augments the tonicity of the uterus and the power of its contractions, whether administered systemically or applied directly to the excised organ. Cerna found that in hydrastine poisoning the salivary and biliary secretions are largely increased, especially the latter. Marfori ascribes a certain cumulative action to hydrastine. The drug is excreted largely or exclusively in the urine, in unchanged form.

Report of experiments on dogs showing that intravenous injection of fluidextract of hydrastis causes a prompt fall of blood-pressure. With small doses the pressure promptly returns to normal and there may be a slight rise above normal. With larger doses (from 0.07 c.c. to 1 c.c. per kilogram—1.2 to 16 minims per 2½ pounds—of body weight) there is only partial recovery, or the pressure may remain low. The pressure changes are attributable to depression, followed by stimulation, of the heart muscle. Very large doses depress and paralyze the vagus and vasomotor system; otherwise there is no evidence deduced from the myocardiograms and oncometer that the vasomotor system plays any important rôle in the blood-pressure changes.

Hydrastine and berberine cause qualitatively the same blood-pressure changes, although berberine is the most active and is responsible for about 85 per cent. of the effect of hydrastis. Hydrastis given by the

mouth' or hypodermically causes no change in the blood-pressure, heart rate, or respiration. Hydrastinine causes a rise of blood-pressure above normal, usually preceded by a slight fall when injected intravenously. The rise is well sustained, and is principally caused by stimulation of the cardiac muscle. W. Whitridge Williams (Jour. Amer. Med. Assoc., Jan. 4, 1908).

*Berberine* in large doses causes merely a loosening of the bowels, without general symptoms. Poisonous amounts cause, in addition, tremor, a fall in blood-pressure, general weakness, and albuminous or bloody urine, followed either by slow recovery or, after hypodermic administration of the drug, possibly by death from respiratory failure.

*Hydrastinine* differs from hydrastine in causing a more marked and more prolonged rise in blood-pressure. This is owing to the fact that it does not depress the heart like hydrastine, though constricting the vessels by stimulation of the vasomotor center and possibly also of the vessel walls themselves. (Bunge, in his experiments, observed contraction of the spleen due to the action of the drug on the vessels.) Another difference between the two alkaloids is that hydrastinine lacks the exciting effect of hydrastine on the spinal cord, as well as its paralyzing effect on muscular tissue in general. According to Cushny, small doses of either alkaloid slow the heart somewhat by stimulation of the vagus center in the medulla; this appears to conflict with the statement of others that therapeutic doses tend to increase the cardiac rate. Upon the medullary centers, hydrastinine acts like hydrastine, causing, *e.g.*, acceleration of the res-

piration in small amounts and paralysis in toxic doses. According to Paldrock, the renal vessels are dilated by hydrastinine, in contrast with the constricted vessels elsewhere. Hydrastinine excites uterine contractions in the same way as the parent alkaloid, but acts more powerfully, almost rivaling ergot (Kehrer).

There is an appreciable difference between the actions of hydrastis and of ergot, as hydrastis does not produce tetanic contractions of the uterine muscle. Animals respond promptly to ergotin and hydrastis hypodermically. Suggestion that hydrastis and ergotin be employed together, to avoid the great increase of intra-uterine tension and tetanic contractions caused by ergot. Fellner (Archiv f. Gynäk., Bd. lxxviii, Hft. 3, 1906).

Uterine contractions are excited by hydrastis and ergot even though the uterine nerves are absolutely cut off. Hydrastine and hydrastinine are much stronger than hydrastis. Hydrastine, hydrastinine, styptol, and stypticin all have a perceptible action in a dilution of  $\frac{1}{200000}$ , and are of practically the same value. The action occurs in all stages of development of the uterine muscle, from birth on through all stages of pregnancy. Berberine and berberinine have no action on the uterus. Uterine contractions from hydrastis or ergot follow independently of blood-vessel contraction. The close resemblance between ergot, hydrastis and cotarnine preparations speaks against the use of the last two in hemorrhage during pregnancy. Kehrer (Monats. f. Geb. und Gynäk., Bd. xxvi, H. 5, 1908).

**CONTRAINDICATIONS.** — According to Marini, hydrastis slackens the cardiac beats when given in large amounts; in such doses it is therefore contraindicated in persons with a permanently slow pulse and in chronic cardiac affections.

**POISONING.**—The symptoms of poisoning by hydrastis are largely those of circulatory and respiratory depression, the convulsive apparently not having been noticeable in the cases so far recorded. Miodowski reports a case in an elderly man who had been ordered 20 drops of the fluid-extract three times daily on account of bronchitis. After two doses there appeared dyspnea, lividity, inspiratory râles, whistling expiration, and feeble heart action. Gradual improvement took place after the use of stimulants (ether, wine, coffee, mustard paper, etc.). The symptoms were presumably due to the heart weakness, with secondary congestion and edema of the lungs. No fatal cases of poisoning by hydrastis have been reported.

Case of poisoning due to fluid-extract of hydrastis. A girl of 22 years, because of marked uterine hemorrhage following abortion, took about  $3\frac{1}{2}$  drams (14 Gm.) of this preparation. She soon developed nausea, vertigo, faintness, restlessness and headache; and later, hallucinations, dyspnea, and precordial oppression. A few hours after, the patient vomited a thick, dark-green liquid. There was great weakness, pallor, and some cyanosis; the heart sounds were weak, the pulse rate 46, and the temperature  $97^{\circ}$  F. ( $36.1^{\circ}$  C.). The symptoms improved, and the patient was discharged cured after five days. Friedeberg (Centralbl. f. innere Med., Oct. 18, 1902).

**THERAPEUTICS.**—Subacute or chronic inflammation and lowered tone of mucous membranes constitute an indication for the local use of hydrastis, to which marked benefit in such affections has been ascribed. Among the conditions in which its employment is suitable are chronic **gastrointestinal catarrh**, especially that resulting from continued alco-

holic indulgence, **subacute catarrh of the biliary passages** causing jaundice, and similar affections of the nasal, urethral, cystic, uterine, and vaginal mucosæ. Sängner recommends the fluidextract administered internally in doses of 20 or 30 drops four times a day to relieve cough in **pulmonary tuberculosis**. The drug has also been used with asserted marked and persistent benefit in **chronic bronchitis** with profuse expectoration. H. M. Jones reported excellent results from application of the tincture as a cervical dressing on the vaginal tampon, or its addition to the water used for a hot douche, in **cervical erosion** and **chronic endometritis**. In **gonorrheal infection of the vagina** in the female, and **leucorrhea** in general, irrigation with an infusion of 2 drams (8 Gm.) of powdered hydrastis in a pint (500 c.c.) of water has been recommended. **Gonococcal urethritis** in the male may be similarly treated in its subacute stage, by injections of 0.25 to 0.5 per cent. hydrastine hydrochloride or the fluidextract (10 to 20 minims to the ounce of mucilage—Wood) directly into the canal, with simultaneous use of the fluidextract by mouth. In **spermatorrhea**, instillations of hydrastine are frequently beneficial. **Vomiting of pregnancy** is another condition in which hydrastis is asserted to have given good results. In **mucous** or **ulcerative colitis**, bowel irrigations with 1.5 to 5 per cent. dilutions of the fluidextract or glycerite of hydrastis have proven very serviceable. In the **gastric crises of tabes dorsalis** a mixture of the fluidextracts of hydrastis and belladonna with chloral hydrate is useful to keep up the anodyne effect of morphine, while in **retention and incontinence of urine** in the same dis-

ease a combination of hydrastis with belladonna or hyoscyamus will likewise yield good results (Collins and Zabriskie).

Among the various expectorants, hydrastine hydrochloride is one of the best. It possesses a remarkable effect in loosening tenacious mucus and aiding its expectoration, in **chronic bronchitis** especially. The author administers it in doses of  $\frac{1}{2}$  to 1 grain (0.032 to 0.065 Gm.) three or four times a day. M. Sanger (Wiener klin. Rundschau, Nos. 19-20, 1902).

In **capillary hemorrhages** the dose of hydrastine hydrochloride is  $\frac{1}{4}$  to  $\frac{1}{2}$  grain (0.01 to 0.03 Gm.), repeated every two hours until effect. Its action in these cases is too slow for emergencies, and on such occasions other remedies must be relied on. J. M. French (Med. Council, June, 1908).

In **atonic dyspepsia** the bitter stomachic influence of berberine is often of considerable value, though the more marked stimulant action of hydrastine on the spinal cord would seem to be an advantage in favor of the administration of the whole drug—hydrastis—the action of which appears to resemble that of nux vomica more than does that of berberine.

A second group of conditions in which hydrastis has been extensively used is that having as common manifestation **hemorrhage**, which hydrastis, and especially hydrastinine, are considered capable of relieving through constriction of the vessels. The drug is rather slowly absorbed and cannot be expected to give results when given by mouth in emergency cases. On the other hand as a preventive, *e.g.*, in **epistaxis**, Kohn found 10-drop doses of the fluidextract every two or three hours very effective. Similarly, in **hemoptysis** Koniger recommends 20- to 30- drop doses

several times daily, and in the **intestinal hemorrhage** of **typhoid fever** and **dysentery** the drug has also been used. To secure a prompt effect in rebellious epistaxis,  $\frac{1}{4}$  grain (0.015 Gm.) of hydrastinine hydrochloride should be given subcutaneously.

It is chiefly in gynecological conditions, however, that hydrastis and its derivatives are employed. In **dysmenorrhea**, whatever be its cause, administration of 20 to 30 minims (1.25 to 2 c.c.) of hydrastis fluidextract in black coffee, beginning eight to ten days before the expected period, together with suitable baths and the drinking of saline waters, will prove beneficial (Montgomery). Similarly, in **menorrhagia**, hydrastis or one of the related alkaloids may be of value. Fuchs found 20 minims (1.25 c.c.) of the fluidextract four times daily effective in menorrhagia associated with **uterine fibromyoma**, while Jones considers the drug of special value in hemorrhages of the **menopause**. Porak and Kallmorgen recommend hydrastinine in preference to the crude drug, the latter giving the alkaloid in  $\frac{1}{2}$ -grain (0.03 Gm.) pills; in cases of **functional menorrhagia**, 2 of these pills are ordered taken daily for a day or two before the expected period, and when the flow commences 3 pills a day are used until it ceases. In **hemorrhage after abortion**, and in that due to lesions of the appendages, hydrastinine usually proved efficacious in Kallmorgen's hands; in the hemorrhage of uterine cancer, however, it has been repeatedly tried without result. Herzfeld, in hemorrhages arising from uterine deviations, serious abnormal puerperal conditions, and gonococcal infection, found hydrastine superior to ergot; it

controlled the bleeding within a few days at most. The dose used was 0.025 Gm. ( $\frac{1}{8}$  grain) four times daily.

Berberine is indicated as a simple bitter wherever there is a lack of tonicity of the intestines, with constipation or passive relaxation, and in **enlargement of the spleen**, where it is well used in conjunction with quinine. In **menorrhagia**, **metrorrhagia**, and **subinvolution of the uterus**, it is inferior to hydrastinine. In **malaria** as much as 15 grains (1 Gm.) may be required daily, in divided doses; but even here  $\frac{1}{8}$  grain (0.01 Gm.) every waking hour is usually sufficient. It is much more effective to keep the blood saturated with the remedy given in small doses than to give a single large dose.

Hydrastine hydrochloride, 3 grains to the ounce (0.2 Gm. to 30 c.c.) of glycerin, is useful in some cases of **granular conjunctivitis**. It is also used in **nasal catarrh** and **leucorrhea**, both internally and locally. When combined with strychnine and capsicum, it is the best substitute for alcohol. The specific use of hydrastinine is in restraining **uterine hemorrhage**. It is slower in its action than ergot, but more lasting in its effects. In **hemoptysis** it should be continued for a week or more after the hemorrhage has ceased. J. M. French (Amer. Jour. Clin. Med., Aug., 1906).

Hydrastinine hydrochloride used to check bleeding of the oozing, long-continued type, with uniformly satisfactory results. Report of cases of **uterine hemorrhage**, **hematemesis**, and **vicarious epistaxis** in which good results followed use of hydrastinine by mouth. T. Anderson (Amer. Jour. Clin. Med., Sept., 1908).

In the preventive treatment of **hemoptysis**—tuberculous patients with high blood-pressure, at the menopause, etc.—bi- or tri-weekly injections of 0.04 to 0.05 Gm. ( $\frac{1}{8}$  to  $\frac{1}{4}$  grain) of hydrastinine hydrochloride may be given. In established hemoptysis,  $\frac{1}{8}$  grain is injected once or twice daily until the hemoptysis ceases. Where

its use is protracted strychnine or camphorated oil injections should be given with it. Barbary (Gaz. méd. belge, Apr. 7, 1910).

Synthetic hydrastinine tried in uncomplicated **uterine hemorrhage** and found very satisfactory. It acts particularly well when given prophylactically for some time before hemorrhage begins, and in cases with virgin uteri. Hemorrhage during pregnancy is, however, not to be treated with this drug. H. Offergeld (Berl. klin. Woch., Jan. 13, 1913).

Hydrastinine is more particularly valuable in the **menorrhagias**, taken prophylactically before the menstrual period, twice daily in small dosage, and in larger amount three times daily during menstruation. The period of bleeding is shortened, while tendency to clot formation is overcome. Small doses, as  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.01 to 0.016 Gm.), repeated at  $\frac{1}{2}$  to 1 hour intervals, usually elicit the desired action as well. H. Walther (Münch. med. Woch., April 1, 1913).

In experiments on the uterus, intestine and heart of rabbits, hydrastinine was found to cause partial paralysis of the sympathetic and parasympathetic nerve-endings. Lundberg (C. r. Soc. de biol., Mar. 7, 1925).

Hydrastis may be employed in the same conditions as pituitrin and ergot, such as **uterine bleeding** due to endometritis, metritis and fibroid tumors, in **subinvolution** with bleeding, and in **menorrhagia** or **metrorrhagia** of indeterminate or known origin. It is less effective than the other 2 drugs, but may be combined to advantage with ergot. It is generally used in the form of the fluidextract in 10- to 20-drop doses every 3 hours. P. B. Bland ("Gynecology," p. 282, 1925).

Bossi many years ago recommended large doses of fluidextract of hydrastis—150 to 200 drops in 3 or 4 doses—as an immediate curative agent in post-partum hemorrhage, and also used the drug as a prophylactic against hemorrhage in cases of hy-

dramnios, uterine inertia, etc. Subsequent experience, however, did not effectually support his claims, and there appears to be no ground for advising the use of hydrastis in preference to ergot. While miscarriage can be produced in dogs and rabbits with hydrastine (Archangelski), the oxytocic properties of hydrastis in the human subject do not seem to be very marked, though von Styrk saw miscarriage in the fourth month take place on the third day of administration of 100 drops of tincture of hydrastis for severe cervical catarrh. Marini states that as an oxytocic hydrastis is not so rapid in action as quinine. Faber, administering hydrastine hypodermically to 13 pregnant women, found the drug to bring on uterine contractions in 12 instances.

Cruse found hydrastis useful in the treatment of **night sweats**; he administered 30 minims (2 c.c.) of the fluid-extract at a dose.

Petty used hydrastine or berberine with petroleum emulsion in the **chronic gastric catarrh of alcoholics**, with excellent results, but later gave these up in favor of a dilute solution of ichthyol, which, disguised with cinnamon water, proved still more effective. According to Marini, hydrastis almost constantly exerts a favorable effect on **hemorrhoids**, whether internal or external; irreducible piles can be easily returned after its use. Wegele applies the fluidextract externally for bleeding in the same condition.

In **stomatitis** and **follicular pharyngitis** the glycerite or fluidextract of hydrastis has proven serviceable when locally applied. Likewise in **sluggish ulcerations**, **necrotic cancer-**

**ous areas**, and **chancroids**, dressings of hydrastis exert a favorable influence. In **catarrhal conjunctivitis** and for the general purpose of stimulating the conjunctiva, instillation of a 0.1 to 0.2 per cent. solution of hydrastine hydrochloride has been recommended.

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**HYDROA.** See DERMATITIS (DERMATITIS HERPETIFORMIS).

**HYDROCELE.** See PENIS AND TESTICLES, DISEASES AND INJURIES OF.

**HYDROCEPHALUS.** See HEAD AND BRAIN, SURGICAL DISORDERS OF

**HYDROCHLORIC ACID.**—Hydrochloric acid (muriatic acid; chlorhydric acid; hydrogen chloride) is generally seen as a clear, colorless, pungent, fuming liquid having an intensely acid odor and taste. This does not represent, however, HCl alone, but a solution of it in water, pure hydrogen chloride being an invisible gaseous compound, which is given off from the solution when it is exposed to the air, the visible fumes being the result of union and condensation of the acid gas with water vapor. A saturated or "fuming" hydrochloric acid solution contains about 37 to 40 per cent. by weight of HCl gas dissolved in the water, while the ordinary "C. P." or pharmacopeial acid contains 31.9 per cent. The specific gravity of the latter variety is approximately 1.16. Commercial hydrochloric acid is of about the same strength, but is yellowish in color, owing to the presence of iron from the containers used in its manufacture as well as free chlorine, and also sometimes embodies arsenic to

the amount of 0.25 per cent. Hydrochloric acid is miscible in all proportions with alcohol and water. Upon diluting the concentrated acid with 2 volumes of water its pungent fumes and odor are no longer set free.

**PHYSIOLOGICAL ACTION.** —

In common with other mineral acids, hydrochloric acid in concentrated form is a decided caustic. Its great affinity for water and its tendency to combine with the alkaline bases cause it to attack the living tissues energetically and induce destructive changes. Its caustic action is not as powerful, however, as that of sulphuric or nitric acid, and when applied to the skin it leads to blister formation rather than actual necrosis. Whitish stains are produced when the strong acid comes into contact with a mucous membrane, and here it may, on the contrary, cause sloughing of tissue. Hydrochloric acid, as might be expected from its gaseous nature and volatility, possesses considerable diffusive power and passes readily through animal membranes. Ingested acid which escapes union with the protein bases in the stomach tends to diffuse into the blood and there form salts with the bases of that fluid, setting free the weaker acids. This tends to decrease the alkalinity of the blood and increase the acidity of the urine. It is to be borne in mind, however, that there exists in the body a mechanism having for its purpose to maintain the normal alkalinity of the blood. When an excess of acid enters the system, the normal transformation of ammonia into urea fails to take place as completely as usual, the ammonia uniting with the acid to form a salt and being excreted in combination with it. Furthermore,

acid salts produced through partial neutralization of the acid act as diuretics, promoting their own elimination. A considerable excess of acid is therefore required to threaten seriously the alkalinity of the blood.

When ingested in dilute form and in medicinal doses, the first action of hydrochloric acid is to augment the salivary secretion. It is a general law that acids applied topically check the production of acid secretions from glands, but increase the flow of alkaline secretions. Besides producing a direct effect of this kind, hydrochloric acid also acts reflexly through the cerebrospinal nerves supplying the salivary glands. On reaching the stomach the acid combines with the proteins present there to form acid albuminates (acid metaproteins). Hydrochloric acid is normally an ingredient of the gastric juice (0.2 per cent.). It aids in the transformation of pepsinogen into pepsin, and also assists the pepsin to digest the protein food-principles.

**PREPARATIONS AND DOSE.**—

*Acidum hydrochloricum*, U. S. P. (hydrochloric acid), of 31 to 33 per cent. strength. Used to prepare the diluted and other acids.

*Acidum hydrochloricum dilutum*, U. S. P. (diluted hydrochloric acid), made by mixing 313 parts by weight of the preceding with 687 parts of distilled water, and containing 9.5 to 10.5 per cent. by weight of hydrochloric acid gas. Its specific gravity is about 1.049. It is odorless and does not fume in the air. Dose, 5 to 60 minims (0.3 to 4 c.c.).

Betaine hydrochloride (acidol) [ $C_5H_{11}NO_2.HCl$ ], unofficial, appearing in the form of colorless crystals or made into tablets, freely soluble



in water, and containing 23.8 per cent. of pure hydrochloric acid. This acid is gradually set free when the compound is dissolved in water. Dose, 8 grains (0.5 Gm.); this equals about 18 minims of 10 per cent. hydrochloric acid.

**MODES OF ADMINISTRATION.**—Hydrochloric acid should always be ordered freely diluted with water (or in lemonade or beef juice), and should be taken through a glass tube or straw, introduced far back in the mouth, in order that contact of the acid with the teeth may be as much as possible avoided. As this object is not always completely attained, various other, more safe modes of introduction have been devised. Aaron recommends the ingestion of the usual 15-minim (1 c.c.) doses of the dilute acid in large double-bottomed capsules, made by inserting the top of an "O" capsule into the bottom of an "OO" capsule. Water is, of course, to be subsequently taken as diluent. A more widely used procedure is to employ betaine hydrochloride or acidol, a solid substance which gives off the acid slowly when dissolved in water.

The dose of dilute hydrochloric acid for stomachic purposes is 5 to 10 minims (0.3 to 0.6 c.c.) and the time of administration usually before meals. Larger amounts, employed to assist digestion or obviate fermentation, are given after meals, frequently in divided doses. Boardman Reed finds even 4 or 5 minims (0.25 or 0.3 c.c.) of the acid, added to half a goblet of water, which is taken in small sips at frequent intervals during an hour or an hour and a half after meals, sufficient to stimulate the gastric glands. In cases of com-

plete or nearly complete anacidity the sipping is begun immediately after the meal; otherwise, not until half an hour after it, in order to give time for salivary digestion of the starchy portion of the food. This gradual method of administering the acid avoids the burning of the stomach witnessed in intolerant cases. Where necessary, the dose is gradually increased to 10 or 20 minims (0.6 or 1.25 c.c.).

According to Huchard, hydrochloric acid treatment should not be continued for more than three or four weeks at a stretch, an intermission of two weeks being then made before resumption of the remedy.

Administration of hydrochloric acid aids in bringing about a normal condition of duodenal digestion. The author's usual plan is to give 20 drops of the diluted acid in 2 ounces (60 c.c.) of water fifteen minutes before the meal. It should always be taken through a glass tube and the mouth afterward rinsed with a weak solution of sodium carbonate. For improving the appetite the acid is best given in doses of 10 to 20 drops diluted in 3 ounces (90 c.c.) of water on an empty stomach before meals. The author has observed cases of anacidity in which the acid caused gastric distress. One patient, a decided neuropath, could detect 6 drops of it when surreptitiously given. J. C. Hemmeter (*Amer. Med.*, April 27, 1901).

**INCOMPATIBILITIES.**—Hydrochloric acid is incompatible with alkalies, salts of silver and lead, oxides, chlorates, and permanganates.

**CONTRAINDICATIONS.**—Hydrochloric acid is generally regarded as contraindicated in all forms of gastric hyperacidity and hyperesthesia. Cohnheim and others have advised, however, that in hyper-

acidity accompanied by excessive motor activity of the stomach, in cases where alkalies fail to relieve, the administration of the acid with or after meals be tried, on the theory that the hyperacidity in these cases is actually the result of a too rapid passage of the food from the stomach into the intestine, which can be controlled through the regulating influence of hydrochloric acid in the pyloric region, both by softening the connective tissue and by dissolving and acidifying the proteins themselves. In addition, it acts as an intragastric disinfectant, preventing or arresting abnormal fermentation of the food by destroying any microorganisms present. It is said to prevent the lactic fermentation in 0.1 per cent. dilution (Cushny). Finally, during digestion hydrochloric acid largely governs the state of occlusion or patency of the pylorus, the sphincter of which relaxes when the food in the stomach has become saturated with the acid, the latter being therefore present in excess and in an uncombined state. It is considered a possibility that upon reaching the duodenum the acid reflexly excites the flow of pancreatic juice; it is well known, moreover, to govern the production of the hormone secretion.

In cases of hypoaclidity, hydrochloric acid, artificially administered, will stimulate gastric secretion; even in anacidity or achylia gastrica, if the glands have any secretory power left, the acid will rouse them to activity. The reflex effect of hydrochloric acid on pancreatic activity, as well as its chemical action in the duodenum, whereby carbon-dioxide bubbles are set free through neutralization by the alkalies present and break up the food

into finer particles, probably accounts for the fact that even small doses of the acid may suffice to assist digestion where it is impaired (Wegele).

Experiments on dogs showing that when hydrochloric acid is given before feeding it has no more influence on the gastric secretion than water alone. When given at the beginning of secretory activity, however, the latter persisted longer than after water alone. F. Heinsheimer (*Archiv f. Verdauungs-Krankh.*, Bd. xii, Nu. 2, 1906).

When von Loghen fed hydrochloric acid to rabbits, he found he could control the precipitation of insoluble sodium urate thereby. The author points out, however, that the solubility of urates depends upon the sodium ion concentration of the fluid, and if one accepts the solvent action of hydrochloric acid one must assume that the sodium ion content of the body fluids is reduced by it. In his own experiments the sodium content in hydrochloric-acid-fed animals was not lessened, but increased. Therefore, a different explanation must be advanced for the possible therapeutic benefits from hydrochloric acid in rabbits with artificial deposits of urates. Staal (*Zeitsch. f. phys. Chem.*, Bd. ii, S. 97, 1908).

**POISONING.**—Ingested in concentrated form, hydrochloric acid destroys the mucous membrane of the mouth, epiglottis, esophagus, and stomach; and violent gastroenteritis attended with very alarming symptoms ensues. Pain is present throughout the digestive tract, and vomiting of coffee-ground matter, blood, or even portions of the mucous membrane occurs. With this are associated a feeble pulse and clammy skin. Diarrhea and cramps in the lower extremities may be present, and the urine may show albumin, casts, and blood-cells. Death, when it occurs as

an immediate result of the ingestion of acid, generally takes place from shock due to the extensive destruction of tissue, followed by collapse. If the case is seen very early, the characteristic odor of the acid may be detected in the breath, and a whitish, pungent vapor may be seen issuing from the mouth. This acid is especially likely, owing to its frequently "fuming" condition when taken, to cause spasm or edema of the glottis, which may result in death by asphyxia.

Though it produces a temporary reddish or greenish stain on clothing, hydrochloric acid does not discolor the skin. Cases of ingestion of the acid have been reported in which the mucous membrane of the mouth showed no injury. More typically, however, the epithelial covering of the mouth and esophagus is for the most part lost, or in places adherent in the form of grayish shreds. The mucosa is reddened and swollen and may show a network of injected blood-vessels. In the stomach there is usually found strongly acid fluid of a coffee-ground color the filtrate from which will produce a heavy, white precipitate of silver chloride when added to a solution of silver nitrate. The bared submucous tissues are colored black, any persisting mucous membrane is dull and swollen, and the muscularis and peritoneum, if revealed, present a cooked appearance. In a case referred to by Puppe the duodenum and upper jejunum showed a wide-meshed network of black streaks, corresponding to the summits of the folds of the valvulæ conniventes, laid bare and infiltrated with blood, the intervening spaces, better protected from the acid, pre-

serving a grayish-yellow color. In common with other strong acids, hydrochloric shrinks and renders hard and brittle all tissues, including blood, with which it comes in contact. This distinguishes its effects from the swollen, soft, and slimy appearance produced by alkalies.

Fatty degeneration of various viscera has sometimes been found in cases of mineral acid poisoning that have survived only a few days.

The average fatal dose of concentrated hydrochloric acid may be roughly stated as one tablespoonful, though a much smaller amount may prove lethal if the fumes reach the larynx to any considerable extent. On the other hand, recovery has taken place after ingestion of an ounce of the acid (Wood). Death, if due to the immediate effects, occurs generally in about twenty-four hours, though in some cases the period of survival has been limited to a few hours. Secondary fatal results not infrequently follow as long as several months after the poisoning, from stricture of the esophagus or impaired gastric digestion, with consequent progressive inanition.

Case of hematemesis in a young woman, apparently due to simple ulcer of the stomach. In a few days diphtheritic patches were noted in the pharynx, from which a short *Bacillus diphtheriae* was cultivated; then a long false membrane was coughed up, presumably from the trachea and bronchi. After a fortnight it was found that all the lesions were due to hydrochloric acid, which the patient had drunk. Le Gendre (Presse méd., June 23, 1900).

Case of hydrochloric acid poisoning in a child 2½ years old. There was no staining or erosion of lips, tongue, or mouth. The vomit did not have an acid reaction. Calcined

magnesia was at once administered; also a starch enema with 10 minims (0.6 c.c.) of laudanum, strychnine injections, and brandy by rectum. The child died six hours after taking the acid. Eight or 10 small perforations were found in the lower part of the stomach, which contained dark blood; there were 8 or 10 ounces of blood in the peritoneal cavity; the entire gastric mucosa was blackened and eroded, as was the duodenum for about 2 inches from the pylorus. The wall of the stomach was so thin and rotten that even the softest tube would almost certainly have perforated any part of it. W. Billington (Birmingham Med. Rev., Oct., 1900).

On the ninth day following ingestion of a poisonous quantity of hydrochloric acid, the mucous membrane of the esophagus was expelled in a tubular form. Three months later death took place; hypertrophy of the pylorus, with consequent stenosis, was found. The prognosis is not always bad, as several recorded cases show. In this case, in addition to the dense pyloric scar, there was thickening of the entire gastric musculature. H. Strauss (Berliner klin. Woch., Jan. 11, 1904).

**Treatment of Poisoning.**—In these cases the use of the stomach-tube is contraindicated, unless the patient be seen much earlier than is usually the case. The chemical antidotes are the **alkalies and their carbonates**, especially **magnesia**; otherwise, **lime**, **prepared chalk** (wall-scrapings, if nothing better), **washing or baking soda**, **soapsuds**, and even **dilute ammonia**, all to be administered in an ample amount of water or milk. The administration of **albumin**, **eggs**, **gum arabic** or other **mucilage**, **milk**, **oils**, **barley water**, etc., will act mechanically to protect and soothe the corroded tissues. Even after thorough neutralization of the poison it is best to give milk and very dilute alkaline

**solutions** for some hours (Holland). **Opium** by mouth or **morphine** by hypodermic injection will be useful to relieve the pain and irritation. **Ice** may also be employed. To counteract the great depression present in these cases, **intravenous injections of ammonia** may be made, hypodermic injections of **strychnine**, **atropine**, **camphorated oil**, **digitalis**, etc., given, and **nutrient and stimulant enemata** administered.

**Demulcents** in solid form, allowed to dissolve in the mouth, will bring much relief from the pain of oral and pharyngeal inflammation (H. C. Wood, Jr.).

Case of ingestion of 1½ ounces (45 c.c.) of concentrated hydrochloric acid. Milk, promptly given, was vomited at once in large curds. Twenty-five minutes after the accident there was administered **sodium bicarbonate**, *ad libitum*, in solution, and **lavage of the stomach** was done, using about 1 ounce (30 Gm.) of sodium bicarbonate in a quart (liter) of water. This could not be withdrawn and the tube was found plugged with thick mucus. Another attempt to wash out the stomach was futile, either because of mucus or possibly perforation due to the acid. Apomorphine hydrochloride, ¼<sub>10</sub> grain (0.0065 Gm.), failed to produce emesis in five minutes, and was repeated, also without effect. Still conscious and complaining of pain, the patient was given hypodermically **morphine sulphate**, ¼ grain (0.016 Gm.), and **atropine sulphate**, ¼<sub>100</sub> grain (0.00065 Gm.); more sodium bicarbonate was administered. She complained of thirst, mucus flowed freely from her mouth, and swallowing was difficult. In spite of stimulation she went into collapse about one hour and a half after taking the acid, developed pulmonary edema, and died of respiratory failure in about five hours. Wollheim (Amer. Jour. of Surg., Jan., 1907).

Under certain circumstances **operative intervention** is indicated, either in the period immediately following the ingestion of the acid or as a secondary procedure where difficulty of alimentation, due to stenosis or destructive changes in the gastro-intestinal tract, places the patient's life in jeopardy.

Report of 4 cases of ulceration of the esophagus and stomach due to strong hydrochloric acid. The first case showed enormous dilatation of the stomach after accidental poisoning by strong hydrochloric acid eight months previously. Complete relief was obtained by **Loreta's operation**. Ulceration of the esophagus and pharynx leads to infection of the air passages in these cases, either through the lymphatics or the trachea.

The patient should receive no food, liquid or solid, by the mouth for several weeks, that is, until there is good reason to believe that the injuries have completely healed. When the injuries are serious (as is usual) an operation should be performed within a few days after the poisoning—the sooner, the better. The pyloric portion of the stomach is the part most seriously injured. A **gastroenterostomy** should be performed and two tubes introduced through the abdominal wound, one entering the intestine through the new opening and the other remaining in the stomach; through one the patient can be fed and through the other the stomach irrigated.

The **mouth** should be freely **washed out with warm boric lotion**. Dirty **teeth** should be **cleansed**, diseased teeth should be treated with pure carbolic acid or by extraction, and suppurating alveoli attended to, under local or gas anesthesia if necessary.

The **pharynx** should be **sprayed** frequently with hot boric lotion and twice a day dusted with a little **iodoform powder** through a puff.

As soon as the patient can swallow without pain he should be allowed **hot water** or **hot neutral saline *ad libitum*** and be encouraged to take it. The hot water swallowed should be allowed to escape by the short gastrostomy tube, so that it will tend to wash out the stomach also. In addition, after each meal given by the gastrojejunal tube, the **stomach** should be **washed out with hot water** through the gastric tube. C. B. Keetley (Lancet, Nov. 16, 1901).

Report of 3 cases of ingestion of mineral acids in which, although the stomach was found more or less extensively cauterized at operation, the esophagus was but slightly or not at all injured. Early operative intervention is desirable only where vomiting does not promptly occur and, in addition, neutralizing fluids cannot for some reason be administered or the stomach washed out. **Gastrotomy, evacuation, and irrigation** are then indicated. In other cases operation is not justified unless copious and repeated bloody vomiting later appears, or there is reason to believe perforation imminent. Under these conditions, if there is necrosis of the gastric wall, the sphacelated area should be brought up to the exterior, and gastric rest and alimentation secured by means of a **jejunostomy**. If the area cannot be exteriorized, **resection** is necessary. Where there is no necrosis, the stomach being hyperemic and bluish, **jejunostomy** by the **Eiselsberg-Witzel technique** should be practised. On the whole, the occasion for early intervention is only infrequently presented? Oftener, a secondary operation is necessary because of continued gastric intolerance; this operation should not be delayed after it is plain that serious injury to the stomach has occurred. Where diffuse cicatricial changes are found, or are about to become established, jejunostomy is the procedure of choice, though **gastroenterostomy** may prove sufficient in some instances. Exclusive feeding through

the jejunostomy opening will often lead to such improvement that posterior gastroenterostomy and restoration of oral feeding can later be effected. Where the cicatricial changes are found limited to the pyloric region, the stomach being dilated, gastroenterostomy is alone necessary. X. Delore and L. Arnaud (*Revue de chir.*, April, 1913).

**THERAPEUTICS.** — Internally, hydrochloric acid is used chiefly in gastrointestinal disorders. In **atonic dyspepsia** the dilute acid may be given, either alone or combined with some preparation of pepsin, immediately *after* meals. In **achylia gastrica** with absence of both acid and pepsin from the stomach, Wegele uses the following formula:—

℞ *Acidi hydrochlorici*  
*diluti*,

*Pepsini* ..... āā ʒiiss (10 Gm.).

*Aquæ sterilisatæ* ..... fʒiij (100 Gm.).

M. Sig.: One teaspoonful in a wineglassful of water to be taken with the meal through a glass tube.

Kaufmann points out the fact that hydrochloric acid often proves a better appetizer than the bitter tonics themselves. Where after subsidence of an attack of **acute gastritis** there is anorexia and a feeling of pressure or discomfort in the stomach region, the following combination will be found of value (Bassler):—

℞ *Acidi hydrochlorici*

*diluti* ..... fʒj (30 c.c.).

*Strychninæ sulphatis*, gr. ¼ (0.05 Gm.).

*Elixir gentianæ* (N.

F.) ..... q. s. ad fʒiv (120 c.c.).

M. Sig.: One teaspoonful in a half-glassful of water before meals through a glass tube.

If the acid provokes pain on the empty stomach in these cases, it should be given after the meals, and well diluted.

In **chronic gastritis** Leube and Ewald recommend the administration of hydrochloric acid in divided doses, beginning one-half hour after meals. The total amount—from 10 to 60 minims (0.6 to 4 c.c.), according to individual preference—is placed in a small glassful of water and taken in three doses at fifteen-minute intervals. Combinations with other drugs, such as the following (Kemp), may be used:—

℞ *Acidi hydrochlorici*

*diluti*,

*Tincturæ cinchonæ*

*composita* ..... āā fʒss (16 c.c.).

*Tincturæ nucis vomicæ*, fʒiij (12 c.c.).

*Aquæ sterilisatæ*, q. s.

ad ..... fʒiv (125 c.c.).

M. Sig.: One to two drams in water one-half hour after meals.

Gastric lavage in the same affection may be performed with a solution of 3 fluidrams (12 c.c.) of the dilute acid in 2 quarts (2000 c.c.) of water; besides removing mucus, this will tend to excite hydrochloric acid secretion (Bassler). In **gastric cancer** digestion can frequently be improved by a combination of hydrochloric acid and nux vomica with condurango (15 to 60 minims, or 1 to 4 c.c., of the fluidextract at a dose) and gentian. In this disorder lavage with a solution of the acid may be of great value for purposes of intragastric disinfection. Other conditions indicating the use of hydrochloric acid are **nervous dyspepsia** with subacidity, the subacidity accompanying **chlorosis**, and **chronic gastric dilatation** with subacidity, stagnation, and abnormal food fermentation. Croftan and others have seen good results from the systematic administration of hydrochloric acid in **pernicious anemia**. Martin finds that if these patients sip

5 to 10 drops of the dilute acid in a wineglassful of water in the course of ten minutes after taking food, digestion is frequently bettered and diarrhea arrested. In **chronic heart disease** with muscular insufficiency liberal amounts of hydrochloric acid, well diluted, may be of some assistance in alleviating symptoms referable to the digestive tract (Williamson), though the more direct causal treatment with heart tonics is not to be lost sight of. In subacidity accompanying **hepatic cirrhosis** hydrochloric acid ingested after meals will not infrequently bring about marked subjective relief.

The writer gave 20 minims (1.25 c.c.) of dilute hydrochloric acid in 90 c.c. (3 ounces) of water, two or three times at fifteen-minute intervals, after an Ewald test-breakfast. One hour after the meal the total acidity was always found increased, and in 3 of the 4 tests free hydrochloric acid was present in appreciable amounts. From 15 to 25 minims (1 to 1.6 c.c.) of hydrochloric acid were given in 3 ounces (90 c.c.) of water three times within an hour after the ingestion of a large meat sandwich and 10 ounces (300 c.c.) of water. Nine tests were made. In sixty to seventy minutes after the meal the total acidity of the gastric contents was always found increased, but free hydrochloric acid was never present. Long-continued use of large doses (45 drops three times daily) of hydrochloric acid diminished the total acidity. The author believes the acid to have a depressing influence on the gastric acidity which is not generally recognized. Peptic digestion, however, is accelerated by its use, although in certain conditions large doses in some manner retard peptic digestion. The acid did not seem to stimulate gastric peristalsis to any marked extent. R. F. Chase (Boston Med. and Surg. Jour., Sept. 7, 1905).

In hyposecretion the writer gives 5 to 10 drops of dilute hydrochloric acid several times a day. This small amount has little direct influence on the digestion, but stimulates by reflex action the entire digestive process. Combination of hydrochloric acid with pepsin or other substances is liable to annul the action of the acid completely. E. Fuld (Therap. Monats., Nov., 1910).

**Diarrhea in anacidity** which is not improved by drugs or diet, particularly abstinence from meat, is often relieved by energetic, continuous exhibition of hydrochloric acid. E. Schütz (Arch. f. Verd., Jan., 1923).

Alkiewicz has used well-diluted hydrochloric acid with success as a remedy for **nausea** and **vomiting**, including that of **cholera morbus** and certain infectious diseases, the **vomiting of pregnancy**, and persistent emesis in cases of maldigestion of food in the stomach. The vomiting of food in **neurasthenic** patients, unaccompanied by epigastric burning or soreness, was always controlled, in Tournier's experience, by full doses of the acid. Likewise, in **gastric catarrh** of **alcoholic** origin, vomiting, as well as the sensation of weight and distention after meals and the insomnia, is relieved by the ingestion of hydrochloric acid.

In **acute intestinal catarrh**, provided there be no nausea, dilute hydrochloric acid in doses of 10 minims (0.6 c.c.) three times daily may prove useful as an adjunct to intestinal antiseptics (Kemp), tending to overcome abnormal fermentation in the upper segments of the alimentary tract. Tournier points out that **lienteric diarrhea**, associated with marked hypoacidity, but few or no gastric symptoms, yields in four or five days to generous amounts of the dilute acid, taken in 3 divided doses at half-

hourly intervals after each meal. In **typhoid fever** large doses of the acid were at one time recommended as a specific measure. The only legitimate uses of the drug, however, are to increase the salivary and buccal mucous secretions,—thus tending to prevent or relieve dryness of the mouth and the accumulation of *sordes*,—and more particularly to make good the deficiency of acid in the gastric juice, well known to exist in this and other fevers, *e.g.*, **scarlatina**. It may be given either as a special dose before each meal in water, or added in small amount—20 minims (1.2 c.c.)—to the patient's drinking-water. In cases of **pulmonary tuberculosis** with chronic indigestion, gastric hypoacidity is usually present, and the administration of hydrochloric acid with or without pepsin will be found correspondingly useful; it is sometimes recommended to intermit the drug from time to time. **Oxaluria** is a condition in which hydrochloric acid has yielded good results.

In cases of **poisoning by alkalis** hydrochloric acid, well diluted, may be used as an antidote, though vinegar and lemon juice are more likely to be at hand, and sulphuric acid is often preferable to it, the salts formed with hydrochloric acid being usually soluble and somewhat irritating.

Skin affections symptomatic of imperfect digestion and enterogenous intoxication are frequently improved by the internal use of hydrochloric acid. Among the conditions that may be thus treated are **acne**, **impetigo**, **furunculosis**, **erythema nodosum**, and **urticaria**. In the last-named condition the acid has also been used

topically; likewise in disorders associated with profuse sweating and torpid skin. A tub-bath containing  $\frac{1}{2}$  to 1 ounce (15 to 30 c.c.) of the acid to every gallon of water may be administered in these cases.

Hydrochloric acid is seldom used as a caustic, but may be so employed in **mercurial stomatitis** with sloughing gums, if no better agent is available. Bayliss has obtained satisfactory results in **sciatica** by applications of the acid, undiluted, to the tender spots occurring on the thigh and calf of the leg in this affection. The applications are repeated on successive or alternate nights according to the condition of the skin. They cause no pain or vesication. After each application the limb is enveloped in cotton and loosely bandaged. The same procedure was employed with benefit in patients suffering from intractable pain in the heels and plantar regions as a sequel to **acute rheumatism**.

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**HYDROCYANIC ACID.**—Hydrocyanic acid (prussic acid; cyanhydric acid; hydrogen cyanide; formonitrile), when pure, is a volatile, exceedingly toxic liquid, chemically HCN. It is found in nature in the secretion of certain myriapods and potentially in a few glucosids, such as amygdalin, from which it may be set free by ferments, such as emulsin, and by dilute acids. In the kernels of various common fruits, in the leaves of the cherry-laurel, and especially in the bitter almond, both amygdalin and emulsin occur, and contact with water is sufficient to cause the libera-



tion of a certain amount of the poisonous acid. Hydrocyanic acid was formerly official in a 2 per cent. solution, a colorless liquid having the odor and taste of bitter almonds. Dilute hydrocyanic acid is prone rapidly to decompose,—into ammonia, into formic acid, oxalic acid, and a brown substance,—becoming more or less discolored, and unfit for medicinal use. It should be kept in small, dark-colored, cork-stoppered vials. Among the salts of hydrocyanic, potassium cyanide is official.

#### PREPARATIONS AND DOSE.—

*Acidum hydrocyanicum dilutum*, U. S. P. IX (diluted hydrocyanic acid), containing not less than 2 per cent. by weight of the pure acid. Where possible, it had best be made extemporaneously, mixing 15.54 parts by volume of diluted hydrochloric acid with 44.1 parts of distilled water, adding 6 parts by weight of silver cyanide, shaking, and pouring off the clear liquid after subsidence of the precipitate. Dose, official,  $1\frac{1}{2}$  minims (0.1 c.c.); maximal, 6 to 10 minims (0.4 to 0.6 c.c.).

Of compounds related to or containing hydrocyanic acid, the following are, or were, official:—

*Sodii cyanidum*, U. S. P. IX (sodium cyanide) [NaCN], a white, amorphous or granular powder, deliquescent and exhaling the odor of hydrocyanic acid. It is freely soluble in cold water.

*Potassii cyanidum*, U. S. P. VIII (potassium cyanide) [KCN], occurring in white pieces or a granular powder, deliquescent and giving off an odor of bitter almonds in the air, but odorless when dry. It is soluble in 2 parts of cold water, decomposed by boiling water, and slightly soluble in alcohol; solutions of it in water are strongly

alkaline to litmus. Dose,  $\frac{1}{8}$  grain (0.12 Gm.).

*Oleum amygdalæ amaræ*, U. S. P. (oil of bitter almond), a volatile oil yielding not less than 85 per cent. of benzaldehyde and not less than 2 per cent. nor more than 4 per cent. of hydrocyanic acid; freely soluble in alcohol or ether, miscible in 2 volumes of 70 per cent. alcohol, but soluble only in 300 parts of water. Dose,  $\frac{1}{2}$  minim (0.03 c.c.).

*Aqua amygdalæ amaræ*, U. S. P. IX (bitter-almond water), made by dissolving 1 part by volume of oil of bitter almond in 1000 parts of distilled water and filtering. Dose, 1 fluidram (4 c.c.).

*Spiritus amygdalæ amaræ*, N. F. (spirit of bitter almond), made by dissolving 1 part by volume of the oil in 80 parts of alcohol, and adding enough distilled water to make 100 parts. Dose, 8 minims (0.5 c.c.).

*Syrupus amygdalæ*, U. S. P. VIII (syrup of almond), consisting of spirit of bitter almond, 1 part by volume; orange-flower water, 10 parts, and syrup, enough to make 100 parts. Dose, 1 fluidram (4 c.c.).

*Fluidextractum pruni virginianæ*, N. F. (fluidextract of wild cherry), made from the bark of *Prunus serotina*, which contains a bitter, crystalline glucosid, and yields a small proportion of hydrocyanic acid and benzaldehyde when rubbed up with water. Dose,  $\frac{1}{2}$  fluidram (2 c.c.).

*Infusum pruni virginianæ*, N. F. IV (infusion of wild cherry), each quart (1000 c.c.) of which is made from 10 fluidrams (40 Gm.) of wild-cherry bark, and contains also  $1\frac{1}{2}$  fluidounces (50 c.c.) of glycerin. Dose, 2 fluidounces (60 c.c.).

*Syrupus pruni virginianæ*, U. S. P. (syrup of wild cherry), each quart (1000 c.c.) of which is made from 5 ounces (150 Gm.) of wild-cherry bark, and contains also 26 ounces (800 Gm.) of sucrose and  $1\frac{3}{4}$  fluid-ounces (50 c.c.) of glycerin. Dose,  $2\frac{1}{2}$  fluidrams (10 c.c.).

*Aqua laurocerasi*, B. P. (cherry-laurel water), made by crushing and distilling fresh cherry-laurel leaves with water, and standardizing the resulting distillate to contain 0.1 per cent. of hydrocyanic acid. Dose, 1 fluidram (4 c.c.).

#### PHYSIOLOGICAL ACTION.—

Although certain bacteria are but slightly influenced by hydrocyanic acid, the latter may be designated a general protoplasmic poison, for in nearly all animals and plants it produces a retardation of the oxidative and nutritive processes, which soon ends in death if the amount applied be sufficient. Geppert found that in spite of the convulsions brought on by hydrocyanic acid the tissues of mammals poisoned with it showed a diminution of both oxygen consumption and carbon-dioxide liberation—a combination of effects demonstrating that cellular respiration is interfered with, which is further confirmed by the fact that in prussic acid poisoning the venous blood exhibits the same bright-red color as the arterial, the oxyhemoglobin not being relieved of its oxygen by the tissues, as is normally the case. Much evidence has been accumulated in favor of the view that the action of prussic acid on tissue respiration is due to interference with the activity of intracellular ferments, in particular the ferments which promote oxidation, the oxidases. According to some,

chemical reactions in general are inhibited by it.

Sections of organs from animals poisoned with potassium cyanide showed little or no oxidase when the presence of the latter was tested for with a mixture of alphanaphthol and dimethylparaphenylenediamine. Since in other varieties of poisoning, as by chloroform, carbon monoxide, in asphyxia, etc., the oxidase reaction is clearly positive, the negative results in cyanide intoxication may be ascribed to a destruction or inhibition by this poison of the ferments that stimulate oxidation. H. Raubitschek (Wiener klin. Woch., No. 4, 1912).

In addition to its general protoplasmic action, however, hydrocyanic acid exerts very definite actions on various special portions of the body, which, appearing somewhat earlier in cases of poisoning than that on general metabolism, contribute largely in the production of the symptoms witnessed under these conditions:—

*Nervous System.*—Stimulation of the central nervous system, especially the medulla and lower brain centers, first occurs, convulsions being among the most evident results. This is followed by the opposite effect, paralysis, in which the entire cerebrospinal system appears to participate. The peripheral nerves are not influenced, though if a solution of hydrocyanic acid be applied externally to the skin, partial anesthesia, with a feeling of numbness, will be produced.

*Respiration.*—The respiratory centers are included in the effects on the medulla, already mentioned. The breathing at first becomes very unusually rapid and deep, then irregular during the convulsions, and finally very slow,—though still deep,—cessation ultimately resulting from complete paralysis of the centers.

**Circulation.**—Primary stimulation of the vasoconstrictor and vagal centers in the medulla results in both a rise of the blood-pressure and a slowing of the heart rate. Later, as the stimulation passes into depression, the pressure falls; but the heart rate continues slow, the vagal effect being now replaced by direct depression of the heart by the drug.

Stimulation of the respiration was observed in the rabbit within three seconds after an injection of sodium cyanide into the jugular vein had been started. Stewart having found the average circulation time from the left jugular to the right carotid in the rabbit to be 2.8 seconds, it is obvious that the cyanide acts almost instantaneously on reaching the respiratory center. A rise in the blood-pressure from 85 to 136 mm. Hg, and a fall in the heart rate owing to cardioinhibition, took place in six seconds after the beginning of the injection. H. S. Gasser and A. S. Loevenhart (*Jour. Pharmacol. and Exp. Therap.*, Jan., 1914).

On the blood of the living body, hydrocyanic acid seems to exert no direct effect. In drawn blood, however, it tends to combine with the hemoglobin to form the so-called cyanhemoglobin, to which is ascribed the occasional persistence of a life-like red color in the dependent portions of the body, or the formation of bright-red ecchymotic spots, in subjects that have succumbed to prussic acid poisoning.

**Absorption and Elimination.** — Hydrocyanic acid, whether inhaled or applied to the mucous membranes or an area of abraded skin, is absorbed with great rapidity. Some absorption even occurs from the intact skin. Gréhan found that instillation of the acid in the eyes of mammals caused

death from respiratory paralysis in from two to three minutes. Inhaled or brought into contact with the buccal mucous membrane in large amounts, it will kill almost instantaneously by simultaneous arrest of the respiration and heart action.

Where the dose of hydrocyanic acid taken is not sufficient to produce death, it appears to undergo prompt alteration in the system. Part of it is changed into sulphocyanides, while the remainder is otherwise altered in some as yet unknown manner. As these changes take place, tissue oxidation is released from the restraining influence of the acid, and the venous blood tends to resume its normal bluish aspect.

Excretion of the sulphocyanides formed from the acid takes place rapidly (one-half to one hour) by way of the kidneys. A certain proportion of the volatile acid itself appears also to pass out by way of the lungs.

**UNTOWARD EFFECTS AND POISONING.**—In slightly excessive doses hydrocyanic acid may cause temporary nausea, faintness, giddiness, feeble heart action, and motor weakness.

In large toxic amounts it is one of the most rapidly acting of all poisons. While in most instances of poisoning in human beings a ten-minute interval precedes death, a fatal ending has been known to occur within two minutes, and consciousness may be lost within a few seconds after the drug has been taken. Where the victim survives one-half to one hour recovery is likely to follow, though exceptions to this rule have been recorded.

When the poison is taken into the mouth, a burning, bitter taste, fol-

lowed by salivation and a sensation of burning in the mouth and throat, is first experienced. Giddiness, headache, mental confusion, and nausea appear immediately after, and are followed, in turn, by slow heart action, dyspnea, and extreme motor weakness. The victim commonly drops to the floor a few moments after the taking of the poison, and unconsciousness early supervenes. Violent convulsions frequently follow, soon giving way to complete motor paralysis, the respiration becoming greatly impaired and finally ceasing, while cardiac beats continue for some time after. During the convulsive stage, there may be vomiting and a discharge of urine and feces. The pupils are dilated, the eyeballs protrude, the jaws are clenched together, and froth, sometimes bloody, escapes from the mouth. Circulatory enfeeblement and a clammy skin are marked features. The odor of bitter almonds is a characteristic accompaniment, and may also be observed later, upon opening the body at the autopsy; it tends, however, rapidly to disappear.

Case of a student who let fall a reagent glass containing some hydrocyanic acid. In stooping to pick it up he inhaled the fumes for a moment. Vertigo, motor unrest, headache, small, filiform pulse (128), and enlargement of the right heart, with cyanosis, were noted. The urine showed numerous casts and considerable albumin, and the temperature was 38.3° C. (100.4° F.). These symptoms persisted for a week. (*Deut. med. Woch.*, xxxii, 42, 1906).

Case of a man who was cleaning silver with a solution of potassium cyanide in a hotel, and noticed itching and brown discoloration of the hands and forearms, blackening of the nails, and dizziness whenever he placed his hand close to his mouth.

He finally developed a severe mucous diarrhea, became somewhat delirious for a few days, and experienced pain in the lower limbs, the ankles becoming stiff. Motor power in both legs and arms was then partly lost, and catheterization became necessary. Two months later he was still in bed, with complete loss of power in the lower limbs and almost complete in the upper. There was pronounced muscular atrophy. Only after six months did improvement set in, the muscles slowly increasing in bulk and function returning. Collins and Maitland (*Jour. of Nerv. and Ment. Dis.*, July, 1908).

Autopsies on 2 men killed by HCN while engaged in clearing a ship of the gas after fumigation. The outstanding observations were: Absence of smell of HCN before opening the body; absence of smell in the urine; gaseous distention of peritoneal cavity and intestines; smell of HCN in all serous cavities; concentration of smell of HCN in the lateral cerebral ventricles; intensity of facial lividity; blue nails; pink color of intestines and gastric mucosa; bright pink staining of intima of aorta; uniform blue green color of liver; green color of cerebral gray matter; color and chemosis of conjunctiva; lividity and engorgement of buccal, pharyngeal, esophageal and respiratory mucosæ; extravasation of blood into stomach wall; flabbiness of myocardium; absence of putrefactive changes or odor, and of the ordinary post-mortem staining. G. R. S. Thomas (*Lancet*, June 16, 1923).

Though acting with extreme rapidity, hydrocyanic acid is not, from the standpoint of quantity, as toxic as certain alkaloids, *e.g.*, nicotine and aconitine. The lethal dose of the pure acid in man is considered to be about 1 to 1½ minims (0.05 to 0.08 Gm.). Garstang reported a case of death in an adult after ingestion of 30 minims of the official diluted acid.

Cyanides, *e.g.*, potassium cyanide,

produce the same effects as the free acid, but somewhat larger amounts are required to produce such an effect. Thus, the lethal dose of potassium cyanide is 3 to 5 grains (0.2 to 0.3 Gm.). Commercial potassium cyanide sometimes contains less than 50 per cent. of the pure compound. In some instances the poisonous action of potassium cyanide is exerted more slowly than is usually the case with the free acid.

Potassium cyanide acts as an alkaline escharotic, and lesions due to this action may be observed *post mortem*, viz., swollen and brownish areas on the mucous membranes. The blood will usually be found fluid, but its color is not constant (Sollmann); it may be either very dark or bright red.

**Treatment.**—The stomach should be at once washed out. Where no facilities are at hand, the simplest and least time-consuming procedure will be to give mustard and water and tickle the throat. If there is time, the administration of, say, 20 grains (1.3 Gm.) of potassium carbonate dissolved in an ounce (30 c.c.) of water, followed by a mixture of 10 grains (0.65 Gm.) of ferrous sulphate and ½ dram (2 Gm.) of magnesium oxide in the same quantity of water, is likely to be of considerable utility, the cyanide group being thereby altered to the much less toxic ferrocyanide. The ingestion of a solution of cobalt nitrate and the subcutaneous injection of sodium thiosulphate (hypo-sulphite) are other measures that have been advised. Where hydrogen dioxide solution is immediately available, its addition to the water employed in washing out the stomach has been advised, on the ground that it will oxidize the poison to the rela-

tively harmless oxamide. The experiments of Martin and O'Brien, however, seem to have demonstrated the futility of this measure, the interaction of hydrocyanic acid and hydrogen dioxide *in vitro* requiring from twenty to seventy minutes. In poisoning by potassium cyanide the ingestion of vinegar has been suggested—merely for the purpose of preventing the alkaline caustic action of this salt.

Experiments showing that hydrogen dioxide is practically worthless in cyanide poisoning. Cobalt salts are valuable, but produce gastro-enteritis. Ferrous salts administered with sufficient alkali are as efficacious as cobalt salts. At the body temperature the formation of ferrocyanides is instantaneous. In all mines where cyanide processes are employed there should be kept solutions of ferrous sulphate, weak potash, and a small packet of magnesium oxide, together with a stomach-tube and a suitable receptacle for mixing, so that the remedies can be administered without delay. The authors recommend 1 ounce (30 c.c.) of a 23 per cent. solution of ferrous sulphate; 1 ounce of a 5 per cent. solution of caustic potash; 30 grains (2 Gm.) of powdered magnesium oxide, together with a metal receptacle of 1 pint capacity and a stomach-tube. The first two solutions should be kept in air-tight tubes which can be broken into the receptacle. The powdered magnesia and ½ pint (250 c.c.) of water are then added, and the mixture shaken up and administered. This amount of antidote will counteract 75 grains (5 Gm.) of potassium cyanide. C. J. Martin and R. A. O'Brien (Intercol. Med. Jour. of Austral., vol. vi, p. 245, 1901).

Potassium-cyanide poisoning is not infrequent among workmen occupied in the process of gold reduction, occurring oftenest where the hands and arms are necessarily immersed

in the cyanide-containing solution. Susceptibility varies in different individuals. Poisoning occurs most easily when the solution is very cold. The local symptoms are itching, scarlet specks on the skin merging to form patches, and papular elevations. Giddiness and headache may be experienced. In such cases the author advises that the hands and arms be placed in a very dilute solution of hot **sulphuric acid** for several minutes every hour. The cyanide is acted upon by the sulphuric acid, with resulting liberation of free hydrocyanic acid, which evaporates and is absorbed and eliminated rapidly. The redness of the skin soon fades. J. W. Nolan (Jour. Amer. Med. Assoc., Feb. 1, 1908).

One of the most useful measures in cyanide poisoning appears to be that suggested by Jona, consisting in the immediate free administration of a dilute solution of **epinephrin**, which, by delaying the absorption of the poison (potassium cyanide) through constriction of the vessels in the gastric mucosa, will give time for effectual removal of the gastric contents by mechanical means or neutralization of the poison *in situ* with some chemical antidote.

When 4 to 5 c.c. (1 to 1¼ drams) of a 1:10,000 solution of epinephrin per kilogram of body weight are introduced into a rabbit's stomach within five minutes after the administration of a lethal dose of potassium cyanide (0.01 Gm. per kilo grain per 3¼ pounds) and Martin and O'Brien's antidote given, or the stomach washed out within four or five minutes after the administration of epinephrin, the animal's life is saved. In man the amount of epinephrin used should be about 90 c.c. (3 ounces) of the 1:10,000 solution, followed later by about 50 c.c. (1½ ounces). The following procedure is advised in cyanide poisoning: 1. **Epinephrin**

to be immediately given. 2. **Martin and O'Brien's antidote**, if at hand. 3. **Wash stomach out**. 4. Give more epinephrin. The object of the second dose is to retard the absorption of any of the poison which escapes the washing-out process or antidote. It might also be advisable to give a brisk **saline purge** soon afterward. When the Martin-O'Brien antidote is not at hand, the order of procedure should be: 1. Epinephrin. 2. Washing stomach out. 3. More epinephrin. Jona (Brit. Med. Jour., Feb. 8, 1913).

According to Sollmann, brisk **artificial respiration**, begun immediately, is of assistance in promoting elimination of hydrocyanic acid—where the free acid has been taken—by way of the lungs. In any case stimulant measures will soon be indicated, including **alternate hot and cold affusions** to the face and the chest or back, inhalation or ingestion of **ammonia**, and injections of **ether**, **atropine**, **strychnine**, **caffeine**, or **brandy**. Heat should be applied **externally** in the exceptional, protracted cases.

**THERAPEUTICS.**—Hydrocyanic acid is no longer as extensively employed as formerly in the treatment of disease, the effects obtained from it being procurable as well or better with other less actively toxic agents.

In various forms of **nervous vomiting**, the **vomiting of pregnancy** or that of **hepatic cirrhosis**, the reflex vomiting of **pulmonary tuberculosis**, and that which accompanies some brain diseases, Bartholow suggested the use of a mixture consisting of 1 dram (4 c.c.) of the official dilute acid and 2 ounces (60 c.c.) of cherry-laurel water; of this the dosage advised was one teaspoonful every two to four hours.

In gastric hypersensitiveness or

pain, especially that of nervous origin, —gastralgia,—the dilute acid has been often prescribed as a local analgesic, although, according to W. E. Dixon, the amount generally given is insufficient to produce the effect with which the drug is credited. In **enteralgia** the acid has also been used.

In **cough** arising from irritation in the pharynx or bronchial tubes, and of nervous, persistent character, dilute hydrocyanic acid, given in the dose of 2 or 3 drops in a teaspoonful of syrup of wild cherry, is credited with affording prompt relief. If a continuous effect is required, however, the dose will have to be repeated at ten- or fifteen- minute intervals. Contrary to what one might expect, such repeated administration does not entail danger of poisonous effects, the same rapidity of elimination which necessitates frequent administration of the agent obviating the likelihood of a summated action. A few observers deny the acid all value in cough.

As flavoring agents, the oil of bitter almonds and its preparations, and especially the preparations of wild cherry, as well as cherry-laurel water, are frequently availed of.

Externally, prussic acid is undoubtedly capable of giving relief in **pruritus** and other affections accompanied with itching. In **pruritus**, **lichen**, and the **syphilodermata** Fox has suggested the use of the following:—

- R *Hydrargyri chloridi*  
*corrosivi* ..... gr. j (0.06 Gm.).  
*Acidi hydrocyanici*  
*diluti* ..... f3j (4 c.c.).  
*Emulsi amygdalæ* .. f3vj (180 c.c.).

M. Sig.: Apply externally.

A lotion of  $\frac{1}{2}$  to 1 dram (2 to 4 c.c.) of the dilute acid in 1 ounce (30 c.c.)

of rose water" might also be used. Care should be taken not to apply such a preparation to broken skin surfaces.

Hydrocyanic acid is now rather extensively employed as a destroyer of insects in dwellings, warehouses, and flour mills, as well as on trees and other plant material.

Hydrocyanic acid is, under proper precautions, an excellent remedy for household insects. It is much more effective against all household insects, except beetles, than carbon disulphide. Rats and mice are also killed. The formula per hundred cubic feet of space is: Potassium cyanide, high grade (98 per cent.), 1 avd. ounce (28 Gm.); commercial sulphuric acid, 1 fluidounce (30 c.c.); water, 3 fluidounces (90 c.c.).

Before performing the operation the house must be vacated and all liquid or moist foods removed. All windows are closed and calked, if of loose construction, with wet paper, cotton batting, or gummed paper. A stoneware or crockery jar with a capacity of 4 gallons should be placed in each room, with the exception of large rooms requiring a charge of more than 3 pounds of cyanide, when the charge may be divided.

After placing the water in the generators, the acid is then slowly poured in. The cyanide, in a thin-paper bag, is finally, when all the receptacles have been gotten ready, dropped into the combined acid and water mixture.

The poisonous hydrocyanic acid gas will not be given off to any extent for a few seconds or a quarter of a minute, and there is therefore time to leave the room quickly without danger of breathing it. The gas being lighter than air, the operation of dropping the bags of cyanide into the diluted acid must be begun at the top of the house. The house should then remain closed for twenty-four hours. The doors are then

opened and the windows lowered from the outside. After an hour's airing the house may be entered if no strong odor of gas is detected. L. O. Howard and C. H. Popenoe (U. S. Dept. of Agric., Bureau of Entomol., Circ. No. 163, 1912).

Report of 6 deaths following fumigation with HCN. W. D. McNally (Med. Jour. and Rec., Feb. 6, 1924).

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**HYDROGEN DIOXIDE.**— Hydrogen dioxide (hydrogen peroxide; oxygenated water), in a pure, undiluted state, is an odorless, colorless, syrupy liquid having the composition  $\text{H}_2\text{O}_2$ . It is unstable chemically, readily decomposing into oxygen and water, and is rarely met with in its pure state. A 30 per cent. solution (by weight) in water can, however, be readily procured. For medicinal and surgical uses a 3 per cent. solution is official. In spite of this relatively great dilution, the solution deteriorates upon exposure to heat, sunlight, or prolonged shaking. It has become almost everywhere the custom to add a small amount of acetanilide to hydrogen dioxide solutions for the purpose of obviating this decomposition, and A. M. Clover has shown by experiment (1913) that this is an extremely efficient procedure, a pure dioxide solution to which 1:2000 of acetanilide had been added deteriorating only 2.7 per cent. in five months, while the same solution, without acetanilide, lost one-half of its strength in three weeks. Acids, especially phosphoric acid, also act as preservatives, but are much less efficient than acetanilide. Pressure exerts no restraining influence on the

decomposition, and the degree of deterioration can be roughly estimated by observing the pressure on the stopper in opening a tightly sealed bottle.

In no case should hydrogen dioxide be stocked for longer than six months by the retailer. While 3 of 5 samples examined were standard, or practically so, as regards strength, in these same 3 the decomposition of the acetanilide used for preservation had progressed to such a point that the color, odor, and taste were extremely marked and the preparations unfit for use. Pure peroxide that is reasonably stable is much to be preferred to one that has undergone partial acetanilide oxidation. (Quarterly Bull. State Board of Health of N. H., July, 1912.)

#### PREPARATION AND DOSE.—

*Liquor hydrogenii dioxidi*, U. S. P. (solution of hydrogen dioxide), which contains, when fresh, about 3 per cent. (by weight) of absolute hydrogen dioxide, corresponding to about 10 volumes of available oxygen. It occurs as a colorless, odorless liquid, with a slightly acidulous taste, owing to the presence of a small amount of acid added as preservative. When slowly heated on the water-bath to a temperature not exceeding 60° C. (140° F.) the solution loses water, chiefly; but if rapidly heated, it often suddenly decomposes. Deterioration on keeping is said to be retarded by replacing the stopper in the bottle with cotton. Dose,  $\frac{1}{2}$  to 2 fluidrams (2 to 8 c.c.).

Unofficial preparations which contain or act in a manner similar to hydrogen dioxide are as follows:—

Perhydrol, a 30 per cent. (*i.e.*, 10 times stronger than the official) solution of hydrogen dioxide, free from acid. The preparation is itself stable,



but deteriorates rapidly when diluted with water. Not used internally in pure form.

Perhydrol is a clear neutral fluid which disengages 100 times its volume of oxygen when decomposed. Despite the fact that it is free from even traces of acid, it will keep for more than one year. J. Klein (*Rev. trimestr. suisse d'odont.*, vol. xiv, No. 4, 1904).

Magnesium peroxide, a mixture containing not less than 15 per cent. of magnesium dioxide ( $MgO_2$ ), together with magnesium oxide. It occurs as a white powder, nearly insoluble in water, but gradually decomposing in its presence into hydrogen dioxide and magnesium hydroxide, these compounds reacting, in turn, with liberation of oxygen. Magnesium dioxide is decomposed by dilute acids, a solution of hydrogen dioxide being formed. The product is of value as a gastric and intestinal antiseptic, and has also been used in anemias, rheumatism, and gout. Dose, 4 to 8 grains (0.25 to 0.5 Gm.).

Zinc peroxide, a mixture containing not less than 45 per cent. of zinc dioxide ( $ZnO_2$ ), together with zinc oxide. It occurs as a yellowish, bulky, tasteless powder, nearly insoluble in water, but gradually decomposing in its presence, with liberation of a maximum of 8 per cent. (by weight) of oxygen. In its dry form it is sterilizable by heat without decomposition. Used externally as dusting powder, with or without admixture of tannic acid, or in a 10 per cent. ointment.

Calcium peroxide, analogous to the preceding, yielding 13.4 per cent. (by weight) of oxygen. Dose, 1 to 5 grains (0.06 to 0.3 Gm.) in water or with sodium bicarbonate.

Strontium peroxide, analogous to the preceding, yielding 11.3 per cent. of oxygen. Used externally as powder or in an ointment.

Sodium peroxide, containing at least 90 per cent. of pure sodium dioxide ( $Na_2O_2$ ). It occurs as a white or yellowish powder, which dissolves in water to form hydrogen dioxide, from which oxygen is liberated by the heat of the reaction. It is a powerful oxidizing agent, igniting ether on contact, and its solution being strongly alkaline, owing to the production of sodium hydroxide, it is employed only externally in acne, in the form of a paste with liquid paraffin or, to remove comedones, as a soap.

Sodium perborate [ $NaBO_3 \cdot 4H_2O$ ], containing 9 per cent. (by weight) of available oxygen. It occurs in white, soluble granules, decomposed by water into hydrogen dioxide and sodium metaborate, and yielding oxygen when heated to  $60^\circ C.$ , or brought into contact with animal tissues or catalyzers. Used as antiseptic and deodorant in suppurative lesions, ulcers, wounds, etc., either applied as a dusting powder or in 2 per cent. solution. It differs from the official hydrogen dioxide in furnishing an alkaline instead of an acid solution.

#### PHYSIOLOGICAL ACTION.—

Taken into the mouth, the official solution foams and produces a slight pungent, stinging sensation. Its properties are those of a deodorant, germicide, and hemostatic. Its effects are produced by the liberation of oxygen and by consequent oxidation. It destroys rubber, cork, catgut, etc.; and when brought into contact with pus or blood, liberates oxygen

very actively, producing an effervescence.

The "explosive" manner in which it sometimes acts may even distend and rupture tissue and carry infection into the cellular tissues for a considerable distance. Spencer has reported a case of mammary carcinoma in which injection of a small sinus with it resulted in opening up and introduction of infection into the axilla. Taken internally, hydrogen dioxide is not actually poisonous; but it may prove irritating, especially in the bowel.

Hydrogen dioxide kills infusoria and probably other isolated cellular elements, but living tissues do not suffer through any chemical influence it possesses. A 3 per cent. solution of it is the equivalent of a 1:1000 corrosive sublimate solution acting on bacteria suspended in aqueous solutions, but hydrogen dioxide is superior to sublimate in media rich in albuminous fluid and poor in cells. In so far as conclusions can be drawn from test-tube reactions, the antiseptic action of the dioxide can be developed in urine and drinking-water, provided decided quantities of albumin are not present; on the other hand, in conditions met with in wounds where catalytic tendencies are marked no more effect will attend its application than the use of sublimate or aluminum acetate. The foaming caused by the dioxide effects a cleansing of wound surfaces without any injurious action, whence its superiority over acetate of aluminum or sublimate solutions. As a deodorizer it acts instantaneously and powerfully. Honsell (Beiträge klin. Chir., Bd. xxvii, H. 1, 1901).

Colloidal silver hastens the decomposition of hydrogen dioxide without being altered itself. This combined action is extraordinarily effective in cleansing and disinfecting. A putrid endometritis rinsed with even a weak concentration of the two agents loses

its fetid odor immediately. The colloidal silver acts as a catalyzer. The author injects the two substances independently, through separate catheters, in such a way that they blend as they emerge. Potassium permanganate and hydrogen dioxide also enhance each other's action. The most practical form in which to apply the combination is to make two solutions, (1) by adding 35 c.c. (1 $\frac{1}{8}$  ounces) of 3 per cent. hydrogen dioxide to a liter (quart) of water; (2) by adding 2 Gm. (30 grains) of potassium permanganate and 5 c.c. (1 $\frac{1}{4}$  drams) of diluted (30 per cent.) acetic acid to 1 liter (quart) of water. Decomposition commences as soon as the two solutions come together. One Gm. of the pure  $H_2O_2$  yields about 700 c.c. of oxygen. When the two solutions are blending properly the escaping fluid is colorless; if one of the solutions preponderates, it is colored. Therefore, the receptacles with the two solutions must be at the same height and each be connected with a catheter providing for two currents. An ordinary two-way catheter, such as is used for rinsing the bladder, is convenient in treating inoperable uterine cancer. Füh (Centralbl. f. Gynäk., Bd. xxx, Nu. 35, 1906).

Ptyalin is markedly affected by hydrogen dioxide. A 0.02 per cent. solution inhibits its action slightly, while 0.1 per cent. and stronger solutions practically destroy it. Pepsin and trypsin are relatively immune to its action, not being destroyed by 0.5 per cent. solutions. Rennin, however, is very sensitive, being completely destroyed by a 0.5 per cent. solution and measurably inhibited by a dilution of 1:3000. L. E. Walbum (Berl. klin. Woch., Bd. xlviii, S. 1929, 1911).

Hydrogen dioxide has considerable value in reducing the number of bacteria and the harmfulness of the decomposition products. It cannot, however, be depended on for complete destruction of even such sensitive bacteria as *Bacillus typhosus*, *B. coli*, or *B. prodigiosus* in milk or

water. Commercial preparations of hydrogen dioxide often vary in composition and are not, therefore, to be depended on unless the composition at the time of use is known. Magnesium dioxide tablets, though probably more stable than solutions of hydrogen dioxide, are not soluble and must be pulverized before addition to the substance to be treated, and even then the evolution of hydrogen dioxide seems to be gradual and irregular. Ordinary room temperature is favorable, but a higher temperature is to be preferred, and milk and water should be colored after the period of action to make them palatable and prevent multiplication of the remaining bacteria. For rendering milk and water safe, hydrogen dioxide solutions can at best be considered only an emergency measure. P. G. Heinemann (Jour. Amer. Med. Assoc., May 24, 1913).

Injected subcutaneously in large amounts in herbivorous animals, hydrogen dioxide causes death by general gas embolism; this does not occur, however, in carnivorous animals. Injected intravenously, it causes methemoglobinemia and hemoglobinuria, and tends to destroy the red cells (Colasanti and Brugnola).

**THERAPEUTICS.**—Hydrogen is an active destroyer of false membranes, pus, and pathogenic germs. It is sometimes used as a diagnostic means for the detection of pus, since contact with the latter causes a foaming and frothing until all traces of pus have disappeared. It is also used in dressing wounds, in which it forestalls suppuration and promotes healing.

In the "parenchymatous" form of **hemorrhage** the 10-volume solution of hydrogen dioxide applied with swabs will dry up the bleeding surface with great rapidity. It acts by causing a rapid formation of fibrin in the mouths of the severed vascular

channels. It is easier to handle than hot water, and is free from the risk of burning the parts. It is especially relied upon in **bone operations** such as the radical mastoid, and is also of the greatest service in the surgery of the nose. In **epistaxis** hydrogen dioxide applied to the bleeding area on a tampon will suffice in most cases to bring the hemorrhage to a standstill. In **uterine hemorrhage** hydrogen dioxide solution, injected into the uterus, or applied on strips of gauze, will arrest bleeding.

As a diagnostic agent, revealing the presence of pus, hydrogen dioxide is of great value. If the antrum of Highmore, *e.g.*, is suspected to contain pus, puncture of its nasal wall with a fine trocar and cannula, followed by injection of some of the solution, will soon settle the point, for if pus is present foaming liquid will at once pour from the nose, bearing on its surface characteristic yellow streaks. In suspected **corneal ulcer** hydrogen dioxide is said to be as valuable as fluorescent, effervescence taking place at the spot where the surface is abraded. D. M'Kenzie (The Hospital; The Antiseptic, June, 1908).

In **purulent affections** the application of hydrogen dioxide to the pus-secreting surfaces and cavities is followed by the most satisfactory effects. Unhealthy suppurating surfaces, **bed-sores**, **gangrenous wounds**, necrotic areas, **cancerous** and **syphilitic ulcers**, etc., are all amenable to its beneficial action. Diluted with 4 to 8 parts of water, it may be used as an injection for **gonococcal urethritis** and **leucorrhea**. Suppuration in **infected wounds** is checked and healing promoted by spraying the parts with hydrogen dioxide before applying the dressings. A 1 per cent. solution is frequently used for irrigating and packing such wounds.

Hydrogen dioxide used in cases of **lupus vulgaris**. It was applied daily to the ulcers in the form of a fine spray. The granulations soon assumed a healthy appearance and cicatrization was rapid as well as permanent. Exuberant granulations may be scraped off before treatment with the dioxide. The remedy is also efficient in chronic or **tuberculous abscesses**, after their contents have been evacuated. C. H. Gunson (Brit. Med. Jour., No. 2147, 1902).

The author has used a 30 per cent. hydrogen-dioxide solution in numerous cases of **ulcers** (especially ulcers of the leg) in **mercurial** and **aphthous stomatitis**. He does not recommend it in chancroids or gonococcal urethritis. In **gonococcal endometritis**, on the other hand, he obtained excellent results in about 50 cases of the chronic and subacute type. The best results were obtained with a 15 per cent. solution. After introducing a tubular speculum into which the cervix fit snugly, 15 to 30 minims (1 to 2 c.c.) of the solution were poured into the speculum, and a cotton probe dipped in the solution introduced into the cervix or uterus. Hemorrhage destroys the action of the peroxide. The concentrated solution of hydrogen dioxide has no hemostatic properties; to stop bleeding one must use a 2 to 5 per cent. solution. The author effected cures with 10 to 12 applications repeated every fifth day, the entire duration of treatment being about two months. Paul Richter (Therap. Monats., Nu. 5, 1904).

In **psoriasis** perhydrol rapidly removes the scales and prepares the way for further treatment. Excellent results were obtained in **favus** with compresses dipped in a 5 per cent. solution and changed every two hours. Twenty-four hours later all yellow crusts, and with them the diseased hairs, were removed and a clean, reddened scalp was exposed. The reddening soon subsided, and three weeks after cessation of treatment there had been no relapse. A

**pigmented nevus** was rapidly removed by painting it with perhydrol. In chancroids, as long as there is a tendency to the spread of ulceration, it appears to be useless, but when the process is at a standstill it rapidly cleans the surface and hastens healing. In **ulcerated cutaneous gummata** the solution, sponged on the surface, acts similarly. In **noma** of the genitals sponging the surface twice daily with the solution and the application of pieces of gauze soaked in a 5 per cent. solution and changed every two hours gave brilliant results. Equally good effects were obtained in **mercurial stomatitis** by painting the ulcerated gums once daily with the concentrated solution, and gargling frequently with a 3 per cent. solution. M. Oppenheim (Wien. med. Woch., Jan. 30, 1904).

In **vulvovaginitis** of young girls a 10 per cent. dilution of perhydrol may be injected into the vagina with a glass syringe. Irrigations are too expensive, but ordinary gauze may be saturated with the solution and introduced through a speculum. **Decubital ulcers** heal rapidly, and **ulcerating carcinomata** lose their offensive discharge and soon present a clean surface. The indications for using perhydrol are, briefly: (1) In all suppurating and ulcerative processes of the vagina and vulva; (2) in all gangrenous processes of the vagina and cervix; (3) in simple **erosion** and marked **leucorrhea**; (4) in severe inflammations of the endometrium, especially after abortions. Walther (Med. Klinik, No. 3, 1905).

In using perhydrol in surgical cases, glycerin is to be preferred to water as solvent, since the evolution of oxygen goes on more slowly and the action is thus prolonged. In **chancroids** the ulcer should be washed with 3 per cent. boric acid solution, next cauterized with copper sulphate, and tampons saturated with 3 per cent. perhydrol-glycerin then applied and renewed three times a day. Good results were also obtained in **ulcers** about the **nails**,

**abscesses, osteitis, and periostitis.** C. Giglio (*Gaz. degli Osped. e delle Clin.*, No. 124, 1905).

Perhydrol in a dilution of 1:9 recommended in **abscesses** of the **antrum of Highmore**, and **wounds and ulcers** of the mouth in general. Some use it in place of absolute alcohol to irrigate **carious cavities**, others in **pyorrhea alveolaris**. E. Friedlander (*Aerzt. Vierteljahres-Rundsch.*, Nu. 3, 1908).

Hydrogen dioxide is a most efficient uterine and vaginal antiseptic. It does not cause local irritation and works its way well into the mucous folds, and fears of gas embolism are groundless. The author first had recourse to it in a case of **puerperal infection** in which the usual remedies had failed to give relief. With a double-current cannula, he injected about 1 ounce (30 c.c.) of a 3½ per cent. solution of hydrogen dioxide into the uterine cavity. This was repeated every twenty-four hours for six consecutive days. The injections were painless and effected a rapid amelioration of the local and general symptoms, the patient becoming apyretic and convalescent at the end of six days. Prompt results were also obtained in the case of a woman 32 years of age who after an abortion at six months presented a **subacute endometritis** with hemorrhage. After curetting the uterus, the author injected about 1 ounce (30 c.c.) of hydrogen dioxide. The resulting foamy scum swept out of the uterus blood-clots and particles of mucus and mucous membrane. The hemorrhage ceased promptly, so that the author was able to operate without tampons. F. Grandoni (*Semaine méd.*, Sept 27, 1911).

Hydrogen dioxide may be successfully used in **abscess of the brain**. In old **sinuses** its employment should be followed with balsam of Peru, which encourages granulation (Morris); or, one may alternate its use with injections of a mixture of

equal parts of ether and balsam of Peru—a procedure of great value in all suppurating cavities with indurated edges (Graff). Where the dioxide is injected into cavities one must see that there is free exit for the gas liberated from it.

According to Pane, hydrogen dioxide acts more strongly against **anthrax** bacilli than mercury bichloride, impeding their growth and after some days killing the spores when mixed with the fluid culture medium in the ratio of only 1 to 352.

In **acute otitis media** the procedure followed by Politzer consists in syringing the meatus with warm sterile water, filling the passage with hydrogen-dioxide solution while the patient's head is tilted on the opposite side, and then inflating the ear with the Politzer bulb through the Eustachian tube, air being thus blown through to the meatus and the liquid finding its way into the tympanum. This treatment may be employed soon after the beginning of the discharge. If no diminution of secretion takes place in a few days resort should be had to boric acid. In **chronic otitis media** a rapid diminution of the discharge is, in a certain proportion of instances, observed after several days' use of hydrogen dioxide, and in a few cases its complete disappearance. Especially in the septic, neglected forms of otitis, treatment may be advantageously begun with hydrogen dioxide, and after several days the ordinary antiseptic treatment pursued, the latter acting more rapidly when preceded by the use of the dioxide. In desquamative suppuration of the middle ear, masses of epidermis heaped up in anfractuositities of the

tympanic cavity, inaccessible to ordinary syringing, are often brought to the surface during the rapid liberation of gas following the introduction of hydrogen dioxide (Politzer). After the "foaming" is over, the otitic ear should be carefully dried out, and some suitable astringent or chemically antiseptic solution may then be instilled. Where drainage of the middle ear through the tympanic membrane is not free, caution should be exercised in the use of hydrogen dioxide.

Obstructive masses of cerumen in the ear can be, to some extent, disintegrated by placing a small quantity of hydrogen-dioxide solution in contact with it for a few minutes, after which the plug can be removed by syringing with warm water. The strength of dioxide solution used in the ear is generally 1 or  $1\frac{1}{2}$  per cent., i.e., a 1 in 3 or 1 in 2 dilution of the official 3 per cent. solution.

In **subacute and chronic suppuration of the middle ear** hydrogen dioxide is a very useful application, acting as a disinfectant and deodorant, and to some extent also as an astringent, the active effervescence occurring when it comes into contact with blood or pus, exerting a mechanical action which helps in the breaking up of masses of septic material. The author has never observed any signs of irritation from the use of the 10-volume strength when a pure preparation was used.

When discharge from the ear is profuse, one should first wash away the pus with a syringeful of warm lotion or boiled water, and then fill the meatus with hydrogen dioxide (cold), the patient holding the head well over to one side. The effervescence should be allowed to go on till it ceases, or at least for several minutes, a little fresh dioxide being added from time to time. The froth

and débris are then syringed out and the parts dried and dressed as desired. Thus, in cases with considerable destruction of the drumhead and good drainage the meatus may be dried with pledgets of absorbent cotton, and then filled with powdered boric acid; or if granulation tissue be much in evidence, with perhaps a smallish perforation and imperfect drainage, drops containing alcohol (25 to 100 per cent.) may be instilled. Pure cerumen is not much affected by hydrogen dioxide, but plugs of epidermal and mixed nature are generally rapidly softened by it.

In **perforating mastoid operations** the writer has found the dioxide of use in cleansing foul cavities and in checking oozing from small vessels. The treatment with hydrogen dioxide and alcohol drops, as in chronic otorrhea, answers well in combination with packing after the radical operation. Lamb (*Folia Therapeutica*, Oct., 1907).

Other fields for the use of hydrogen dioxide are the oral and nasal cavities. In **ulcerative stomatitis, dental caries, thrush, tonsillitis**, etc., this agent may be used as a wash or gargle, prepared by adding a tablespoonful of the 3 per cent. solution to a tumblerful of boiled water. In the various forms of **"septic" and membranous sore throat**, however, the best way to apply the remedy is to spray it directly on the inflamed surface. According to some, even **leucoplakia** may be benefited through the use of hydrogen dioxide as a mouth-wash. For **mouth disinfection and deodorization** in febrile and wasting diseases, a 2 or 3 per cent. dioxide solution is decidedly efficient. Walters found 5 to 10 per cent. solutions highly useful in **mercurial stomatitis**. In **diphtheria** hydrogen dioxide has been recommended for the destruction and removal of false membrane. On con-

tact with it an active effervescence ensues, and the membrane comes away in shreds. The dioxide is best applied in spray form, using a rubber or glass-tipped atomizer on account of the oxidizing influence upon metal spray tubes. It may also be applied by means of a swab or a glass syringe. It does not prevent, however, a return of the membrane.

In 6 per cent. strength, hydrogen dioxide forms an excellent disinfectant for the mouth and throat. **Catarrhal and ulcerative stomatitis** yield to its use alone. On account of lack of toxicity it can be used in the youngest children, for if swallowed it can do no harm. Similar considerations apply to **aphthous and mercurial stomatitis**. In **simple and lacunar tonsillitis**, and in tonsillitis accompanying the infectious diseases, gargling with peroxide is very effective. In **laryngeal tuberculosis** the author found it more efficient than lactic acid. The inhalation of the steam from boiling dioxide is useful in laryngeal tuberculosis, as also in **putrid bronchitis**. Edmund Nacht (Aerzt. Cent.-Zeit., Nu. 21-22, 1904).

In **ozena** hydrogen dioxide will rapidly overcome the odor. Removal of intranasal tampons without hemorrhage can be facilitated by moistening with dioxide solution. Application of the 3 per cent. solution to the nasal mucosa, as well as to the uterine cervix, is useful to remove adherent mucus and expose the membrane for local medication.

In disease of the nose the uses of peroxide of hydrogen are chiefly for the **disinfection and removal of purulent discharges**, and for the checking of **hemorrhage**. In operations for the **removal of polypi** an application of a few minutes will usually check the bleeding sufficiently.

In most cases of **epistaxis** a pledget of cotton with dioxide, intro-

duced just beyond the vestibule and pressed against the septum with the tip of the finger applied outside the ala, will, if the pressure be maintained for ten or fifteen minutes, arrest the bleeding. Lamb (Folia Therapeutica, Oct., 1907).

**Membranous conjunctivitis** yields rapidly to hydrogen dioxide. In **marginal blepharitis** Ayers has reported good results from first removing the crusts, instilling cocaine, and rubbing dioxide solution along the edge of the lid with a little cotton wrapped on the end of a toothpick.

In **purulent conjunctivitis**, *e.g.*, **gonococcal and membranous**, hydrogen dioxide gives very satisfactory results. In the former case it should be used in the form of a warm douche (40° C. or 104° F.). The dioxide is not decomposed at this temperature, while the gonococci are destroyed. Whereas silver nitrate is contraindicated in **corneal ulcerations**, hydrogen peroxide is of great use. It disinfects the ulcer and, owing to its peculiar action on the toxins generated, **iritis** and **hypopyon** are less frequently noticed in cases of pneumococcal infection. In **blepharitis** hydrogen dioxide can be recommended for removing the crusts. In the **pannus** associated with **trachoma** or chronic corneal conditions, after the operation of **syndectomy** has been performed, a probe tipped with cotton-wool and saturated with the drug should be rubbed into the gap from which the conjunctiva has been removed. This measure, followed by the instillation of dionin and the injection, subconjunctivally, of salt solution, has brought about removal of many dense *nebulæ*.

**Lachrymal obstruction and purulent dacryocystitis** are greatly benefited by hydrogen dioxide; an obstruction that resists everything else will give way before it. Stretching of the sac wall during the syringing, sometimes causing puffiness of the eyelids and the inner canthus for twelve to twenty-four hours, can be

avoided by using as little force as possible; when much of the fluid has escaped into the tissues, the edema is extensive and may last several days. This does not apply to its use immediately before the operation of excision of the sac, when it is desirable to remove every trace of pus. P. A. Harry (Prescriber, June, 1913).

**Freckles** can be removed by bringing into contact with them a non-acidified 3 per cent. hydrogen-dioxide solution twice daily, for half an hour, and rubbing in with wool-fat thereafter. Other conditions in which the use of dioxide has been counseled are **frostbites**, **pigmented nevi**, **ringworm**, and **furunculosis**. Its application tends to counteract pain and prevent secondary poisonous effects in **bites** and **stings of insects**.

In **powder burns** a dressing or application of hydrogen dioxide, with or without 1 part of glycerin to 3 of the dioxide, assists materially in the removal of stains and embedded particles of powder. When gauze adheres tightly to wounds, saturation of it with hydrogen dioxide greatly facilitates its removal. According to Gallois, hydrogen dioxide, applied with cotton daily for several minutes, affords a simple and painless means of removing **superfluous hair**.

Internally, the use of hydrogen-dioxide solution has been advocated in the **vomiting of pregnancy** and in **hyperchlorhydria**. In the latter condition it has been found capable of causing a marked, though temporary, diminution of free acid in the stomach content.

After giving 15 c.c. ( $3\frac{3}{4}$  drams) of hydrogen dioxide in 150 c.c. (5 ounces) of water the acid in the stomach is much diminished, and after 20 c.c. (5 drams) in the same amount of water it disappears altogether. The inhibitory

action of peroxide upon free acid production is only of short duration, but if teaspoonful doses are given for some time, in cases of **hyperchlorhydria**, it is possible to keep the amount of free acid well within normal limits. The **gastralgia** is also favorably affected in nearly all cases. Girardi (Gaz. degli osped., p. 145, 1910).

Small quantities of hydrogen dioxide, as 4 to 8 c.c. (1 to 2 drams) of the 3 per cent. solution, before meals, once or twice a day, only slightly lower the acidity in cases of **hyperchlorhydria**. Fifteen c.c. ( $3\frac{3}{4}$  drams) have a decided effect, but the patient is nauseated. Giving it in almond water, as suggested by Poly, lessens this trouble. Neilson (Jour. Amer. Med. Assoc., Feb. 7, 1914).

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## HYDROGEN ION CONCENTRATION.

—The actual acidity or alkalinity of a fluid is dependent upon the dissociated ions in it, while the potential acidity or alkalinity relates to the undissociated molecules present, which neutralize added alkali or acid only in proportion as the free ions become combined with such an addition. The actual or true reaction corresponds to the hydrogen ion concentration or  $pH$ , the latter being a symbol introduced by Soerensen for convenience in designating the logarithm of  $1 \div$  the hydrogen ions present in any given solution. In a completely dissociated decinormal HCl solution the hydrogen ions are likewise decinormal, i.e., 0.1 N, or  $1 \times 10^{-1}$  N, and the logarithmic expression of the hydrogen ion concentration, or  $pH$ , is therefore 1.0. With  $\frac{1}{2000}$  normal HCl, the  $pH$  is 2.0 (really  $10^{-2}$ ); with  $\frac{1}{1000}$  normal HCl, it is 3.0, and so on.

**BLOOD.**—The  $pH$  of the blood is, roughly, 7.5 (really  $10^{-7.5}$ ), which corresponds to 0.000,000,032 normal HCl. In this connection it is to be borne in mind that  $pH$  7.0 corresponds to neutrality at  $20^{\circ}C.$ , and  $pH$  6.8 at  $38^{\circ}C.$  Thus, the  $pH$  of the blood, being above 7.0, is said to incline slightly toward alkalinity. The range of



normal variation in the  $pH$  of the blood serum has been stated by Van Slyke as 7.3 to 7.5, by Cullen and Robinson as 7.28 to 7.41, and by Myers and Roohr as 7.35 to 7.43.

To change the reaction of the blood, even *in vitro*, requires a great deal of acid or alkali, as is exemplified by Friedenthal's conclusion that serum requires, to bring about a given change of reaction, 327 times as much  $HCl$  or 30 to 40 times as much  $NaOH$  as would be needed in the case of water.

This marked stability of the  $pH$  of the blood—and this applies to the body fluids in general—is due to the so-called "buffer systems" which, in the case of the blood, as stated by J. H. Austin and G. E. Cullen (Med., Aug., 1925), are, in the order of importance, hemoglobin acid and its salt, carbonic acid and alkali carbonate, serum proteins and their salts, and monobasic and dibasic phosphate.

The methods of determination include the electrometric, such as the gas chain, hydrogen electrode and quinhydrone methods, which, while constituting the procedures of ultimate reference, are too taxing and time-consuming for use other than in research work, and the colorimetric or indicator methods, simpler, in which solutions of indicators giving color effects dependent upon the  $pH$  are used.

The following colorimetric procedure has been described and applied by Austin and Cullen (*loc. cit.*): Blood is drawn without stasis or loss of  $CO_2$  into a tube under paraffin oil containing oxalate to make 0.3 per cent. It is centrifuged in a stoppered tube completely filled with blood. Especial care is taken that neither the blood or plasma is ever exposed to air. One portion of plasma of from 0.2 to 1 c.c. is transferred to 20 volumes of 0.9 per cent.  $NaCl$  solution containing phenol red, which is already covered with oil. Another portion is added to 0.9 per cent.  $NaCl$  solution without indicator. The indicator  $NaCl$  solution is prepared by adding 1.05 c.c. of 0.04 per cent. phenol red to 100 c.c.  $NaCl$  solution and adjusting with  $N/50 NaOH$  to  $pH$  about 7.5. Phosphate standards at 0.05  $pH$  intervals are used containing 0.01 c.c. of 0.04 per cent. phenol red per c.c. The second sample

of plasma in saline is used to superimpose the color of the serum upon that of the standard with indicator. The color of the plasma + indicator tube is compared with the combined colors of phosphate + indicator and diluted plasma in a Walpole comparator. For human plasma:

$$pH_{38^\circ} = pH_{color} \text{ at } t^\circ + 0.01(t^\circ - 20^\circ) - 0.23,$$

where " $pH_{38^\circ}$ " is the  $pH$  of the undiluted plasma at  $38^\circ$ ; " $t^\circ$ " is the temperature (15 to  $25^\circ$ ) of the phosphate standards and diluted serum when read, and " $pH_{color}$ " is the  $pH$  at  $20^\circ$  of the phosphate standard which matches the plasma + indicator tube. " $-0.23$ " is an empirical correction which varies with different species.

For a consideration of the variations in the reaction of the blood under abnormal conditions, the reader is referred to the sections on ACIDOSIS and ALKALOSIS elsewhere in the work (see Index).

**URINE.**—The average hydrogen ion concentration of the urine has been placed at 6.03, with an extreme normal range of 5.12 to 7.46. It is increased, *i.e.*,  $pH$  becomes numerically lower, upon perspiration and fasting. Under abnormal conditions Henderson has recorded an extreme high acidity of 4.7. The acidity is generally increased in abnormal states, *e.g.*, to a  $pH$  of about 4.91 in heart disease. Acid sodium phosphate will increase the acidity, but not beyond the extreme normal range, whereas sodium bicarbonate in large dosage may lower it to an altogether subnormal level, *e.g.*, to  $pH = 8.7$ .

Most of the following facts relating to the hydrogen ion concentration of the urine are from an excellent article on this topic by M. P. Weil (Bull. Soc. méd. des hôp. de Paris, Nov. 20, 1924):

The hydrogen ion concentration ( $pH$ ) of normal urine ranges from 5.8 to 6.2 on a mixed diet. Variations between 6.5 and 5.5 are related almost entirely to variations in the ratio of sodium dihydrogen phosphate to disodium hydrogen phosphate. In urines more acid than this, an increasingly large share is taken by the organic acids. Thus, beta-oxybutyric acid, in individuals in a state of acidosis, is free in the urine to the extent of 33 per cent. when the  $pH$  is 5. In the more alkaline urines, the effect of

carbon dioxide and the bicarbonates begins to be felt at 6.5. Above 7, the extensive elimination of bicarbonates is generally the result of alkaline medication.

After a meal the  $pH$  rises by 0.4 to 2 or even more ("alkaline tide"), because of the secretion of hydrochloric acid in the stomach, which would increase the alkalinity of the blood did the kidneys not intervene by excreting alkali to compensate for it. A meat diet lowers the  $pH$  of the urine, while a vegetable and fruit diet increases it—with the exception that cereals, bread, and the legumins lower it because of their high content of protein and phosphoric acid. Hunger seems to raise the  $pH$  because of a preliminary secretion of  $HCl$  before food has been taken. Starvation, which forces the subject to live on his own tissues, is analogous to a flesh diet and lowers the  $pH$ ; on the second day, moreover, acetone and diacetic acid begin to appear. Nervous disturbances, emotions, work, and especially mental work on account of the sedentary life associated with it, may apparently play a rôle in the production of hypo-acid or alkaline urine. The urinary acidity in the morning is, however, always the same in a given individual, and this is therefore the best time for  $pH$  determination in diseased states. The greater the urinary acidity, the more freely is calcium eliminated in the urine.

Hyperchlorhydria is attended with lowered urinary acidity. The morning urinary acidity seems to be high in gouty and rheumatic states, migraine, eczema, and neuroses. The  $pH$  may fall to 5 and even 4.6 in these cases.

In nephritis, the urinary  $pH$  does not always reflect the blood  $pH$ , on account of the diseased condition of the renal parenchyma.

In diabetics, the urinary  $pH$  may be normal in spite of the presence of acidosis; the same is true of uremia.

Bacterial fermentations in the urinary tract may markedly change the  $pH$  of the urine.

During periods of "alkaline tide" turbidity of the urine may suggest a phosphaturia when no true phosphaturia really exists, the phosphatic turbidity being due merely to the lowered acidity of the urine at these times. Bicalcium phosphate begins to pre-

cipitate at 6.1, tricalcium phosphate at 6.8, and ammoniomagnesium phosphate at 6.6.

For the determination of the hydrogen ion concentration of the urine, colorimetric procedures similar to that described above for the blood are generally employed. S.

**HYDRONEPHROSIS.** See KIDNEYS, DISEASES OF.

**HYDROPHOBIA.** See RABIES.

**HYDROPNEUMOTHORAX.** See PLEURA, DISEASES OF.

**HYDROTHERAPY.** See WATER.

**HYOSCINE.** See SCOPOLA AND SCOPOLAMINE.

**HYOSCYAMUS.**—Hyoscyamus (U. S. P.) consists of the dried leaves, with or without the tops, of *Hyoscyamus niger*, or henbane, collected from plants of the second year's growth. It is naturalized in nearly all temperate regions, including the United States. It belongs to the family *Solanaceæ*, of which belladonna, stramonium, and scopola are also members. The fresh herb has a rank, heavy, unpleasant odor, which disappears on drying. The plant contains three alkaloids, *hyoscyamine*, present in largest amount; *hyoscine* (scopolamine), present in less amount, but more abundantly than in belladonna or stramonium, and *atropine*, present only in traces. The combined percentage of these alkaloids ranges from about 0.03 to 0.25 (most frequently from 0.06 to 0.15 per cent.), of which hyoscyamine constitutes about three-fourths. In addition, hyoscyamus contains hyospicrin, a bitter glucosid; an odorous principle; potassium nitrate, and calcium oxalate (Kraemer).

Hyoscyamine is isomeric with, *i.e.*, has the same chemical formula as

atropine [ $C_{17}H_{23}NO_3$ ], and is distinguished from it merely by its different optical properties. Atropine, when examined in the polariscope, is inactive, because it is a mixture of levohyoscyamine and dextrohyoscyamine, which neutralize each other as regards rotation of the plane of polarized light.

The natural hyoscyamine, on the other hand, which consists of more or less pure levohyoscyamine, rotates the plane of polarized light to the left to a greater or less degree. Levohyoscyamine readily changes to atropine, and a partial transformation of this nature is known to occur during the process of extraction of the alkaloid from the plants containing it.

Hyoscine is chemically identical with scopolamine [ $C_{17}H_{21}NO_4$ ]. No essential distinction is made between the two alkaloids. A relationship between them may be said to exist, however, somewhat similar to that borne by atropine to levohyoscyamine, the term scopolamine being properly applied—through a tacit understanding—to that form of the alkaloid which will rotate the plane of polarized light to the left to the maximum degree of which the molecule under consideration is capable, while the term hyoscine is less precise, being applicable to specimens of the alkaloid ranging from completely levorotatory (in which case the term scopolamine would also be applicable) to optically inactive.

#### PREPARATIONS AND DOSE.—

*Hyoscyamus*, U. S. P. (hyoscyamus), the dried drug, required to yield, when assayed according to the official process, not less than 0.065 per cent. of the alkaloids of hyoscyamus. Dose, 3 grains (0.2 Gm.).

*Fluidextractum hyoscyami*, U. S. P. (fluidextract of hyoscyamus), made by moistening powdered hyoscyamus with alcohol diluted with water (3:1), percolating, evaporating a certain portion of the product, and mixing it with the remainder; the finished product is required to contain 0.055 to 0.075 per cent. of alkaloids. Dose, 3 minims (0.2 c. c.).

*Extractum hyoscyami*, U. S. P. (extract of hyoscyamus), made by evaporating the fluidextract at a temperature not exceeding 70° C., stirring constantly, until it is reduced to a pilular consistence; it is required to contain 0.22 to 0.28 per cent. of alkaloids. Dose,  $\frac{5}{16}$  grain (0.05 Gm.).

*Tinctura hyoscyami*, U. S. P. (tincture of hyoscyamus), made by macerating 1 part by weight of powdered hyoscyamus in diluted alcohol, percolating, and adding enough diluted alcohol to make 10 parts by volume; the product is required to contain 0.0055 to 0.0075 per cent. of alkaloids. Dose, 30 minims (2 c. c.).

*Oleum hyoscyami compositum*, N. F. (compound oil of hyoscyamus; balsamum tranquillans), consisting of 2 parts each by volume of the oils of lavender, peppermint, rosemary and thyme, with enough infused oil of hyoscyamus (a 10 per cent. infusion in sesame oil, after previous maceration with 10 per cent. of alcohol and 0.2 per cent. of ammonia for 6 hours) to make 1000 parts. Uses chiefly external, as anodyne and antiseptic.

*Hyoscyamina hydrobromidum*, U. S. P. (hyoscyamine hydrobromide) [ $C_{17}H_{23}NO_3 \cdot HBr$ ], occurring in white crystals. The salt deliquesces upon exposure to air, and is freely soluble in water, alcohol, and chloroform. Dose,  $\frac{1}{100}$  grain (0.0006 Gm.).

*Hyoscyamina sulphas*, U. S. P. VIII (hyoscyamine sulphate)  $[(C_{17}H_{23}NO_3)_2 \cdot H_2SO_4]$ , occurring in whitish crystals or a white powder, odorless, bitter and acrid in taste, and deliquescent upon exposure to the air. It is easily soluble in water and alcohol, but practically insoluble in chloroform and ether. Dose,  $\frac{1}{200}$  grain (0.0003 Gm.).

*Scopolamina hydrobromidum*, U. S. P. (scopolamine hydrobromide)  $[C_{17}H_{21}NO_4 \cdot HBr + 3H_2O]$ , occurring in colorless, odorless crystals, sometimes of large size, with an acrid, slightly bitter taste, and slightly efflorescent on exposure to the air. It is soluble in 1.5 parts of water; 1.33 parts of alcohol at 60° C. (140° F.); 16 parts of alcohol at 25° C. (77° F.), and 750 parts of chloroform, but is insoluble in ether. Dose,  $\frac{1}{20}$  grain (0.0005 Gm.).

Oil of hyoscyamus, official in the German pharmacopeia, is made by warming 10 parts of olive oil and 1 part of hyoscyamus cut up fine, and previously moistened with alcohol. It is used as an anodyne liniment.

Amorphous hyoscyamine, unofficial, is an impure form of hyoscyamine, probably containing some hyoscyne. It occurs as a brown, syrupy liquid, soluble in alcohol. Dose,  $\frac{1}{8}$  to  $\frac{1}{4}$  grain (0.008 to 0.015 Gm.).

#### PHYSIOLOGICAL ACTION.—

The action of hyoscyamus is that of its main alkaloidal constituent, hyoscyamine, slightly modified by that of hyoscyne. The effects, as a whole, are decidedly milder than those of belladonna, if the same amount of each drug is used, on account of the lower content of alkaloids in hyoscyamus (0.065 per cent.), as compared with belladonna leaves (0.3 per

cent.) and root (0.45 per cent.). It will have been noticed, however, that the official doses of hyoscyamus and its preparations are considerably larger than those specified for the belladonna preparations.

Hyoscyamine acts on the central nervous system precisely like atropine, exerting no effect save stimulation of the respiratory and vasomotor centers in therapeutic doses, but exciting the brain to delirium—followed by stupor—in larger amounts. Peripherally, hyoscyamine acts on the same nerve-endings as atropine, but more strongly (theoretically twice as strongly), the action on these terminals increasing with the levorotatory power of the specimen of alkaloid employed. The chief nerve-endings, depressed or paralyzed by hyoscyamine (as by atropine), are those of the oculomotor in the iris and ciliary muscles; the vagal terminals in the heart, bronchial involuntary musculature, and upper portion of the esophagus, and the secretory nerve-terminations in the glands. The results of these actions, therefore, where the drug is sufficiently pushed, are mydriasis, paralysis of accommodation, cardiac acceleration, relaxation of the bronchial tubes (especially when previously in a constricted condition), difficulty in swallowing, and diminution of the function of all glands that are under nervous control.

On the involuntary muscle tissue of the stomach, intestine, bile-duct, ureters, etc., hyoscyamine exerts the same effect as atropine, tending to stimulate motor activity, while at the same time removing any abnormal spasm in these structures when taken internally in moderately large doses, but depressing the function of the

same muscular tissue when applied to it directly.

The circulatory effects of hyoscyamine are the result of vagal paralysis, stimulation of the vasomotor center, and slight stimulation of the heart muscle directly, and are manifest in a tendency to increased pulse rate and heightened blood-pressure, followed, where large toxic doses have been used, by a secondary depression of these functions. The respiration is affected through the medullary center of breathing in the same manner as the tone of the blood-vessels. Death in animals poisoned with hyoscyamine occurs from respiratory failure.

Hyoscine paralyzes the oculomotor and vagus autonomic nerve-endings and the secretory nerve-endings like atropine and hyoscyamine, the degree of this effect increasing with the levorotatory power of the specimen of hyoscine used, but differs from them in the important particular that the brain-centers are depressed even by small doses and the respiratory and vasomotor centers by intermediate or large doses. The central nervous effects of hyoscine are thus largely antagonistic to those of hyoscyamine and atropine, whence the fact that the whole drug hyoscyamus, containing a notable proportion of hyoscine as compared with belladonna or stramonium, is more of a sedative in its central effects than the two latter drugs.

**POISONING.**—The symptoms and signs of hyoscyamus poisoning are extreme dryness of the fauces and throat, dilatation of the pupils, a sensation of fullness in the head, dizziness, acceleration of the pulse rate, dysphagia, muscular weakness, and a more or less pronounced muttering

delirium, followed by stupor or actual coma. Occasionally, a scarlatinoid eruption like that produced by belladonna is seen.

**Treatment of Poisoning.**—Chemical antidotes, such as **Lugol's solution**, **potassium permanganate**, and **tannic acid**, should be administered, followed immediately by the use of the **stomach-tube**, or, if this be not practicable, an **emetic** and **warm water**. Among the best physiological antidotes may be mentioned **pilocarpine**,  $\frac{1}{4}$  grain (0.015 Gm.), and **physostigmine** (eserine),  $\frac{1}{20}$  grain (0.002 Gm.), both to be administered hypodermically in one of their salts. **Morphine**,  $\frac{1}{4}$  grain (0.015 Gm.), may be used to overcome restlessness and delirium, and an ice-bag applied to the head for the same purpose. Among the suitable stimulants for use in cases where marked secondary depression of the circulatory and respiratory functions appears may be mentioned **strong, hot coffee, by rectum**; **caffeine sodiobenzoate**, 5 to 10 grains (0.3 to 0.6 Gm.), by mouth or hypodermic injection, and **strychnine sulphate** or **nitrate**,  $\frac{1}{20}$  grain (0.003 Gm.) or more hypodermically.

**THERAPEUTICS.**—Hyoscyamus is employed mainly as a sedative to the nervous system. The most common use of it is for the relief of **strangury** and **pain** or painful micturition in cases of **excessive bladder irritability**,—including that occurring in **renal tuberculosis**,—in **cystitis**, and in **gonococcal urethritis**. Where **retention of urine** supervenes in **acute cystitis**, full doses of hyoscyamus, together with opium and hot compresses or turpentine stupes to the abdomen, are of value. A suppository containing  $\frac{1}{4}$  to 1 grain (0.015 to 0.06

Gm.) of the extract of hyoscyamus may be ordered at night. In **enuresis** associated with **colon bacilluria** tincture of hyoscyamus may be given in elixir of buchu at night to diminish bladder irritability; in **tabes dorsalis** the drug may also be used for the relief of enuresis (Jennings). Wellman found hyoscyamus decidedly useful in the treatment of **endemic hematuria** the result of **schistosomiasis**.

In short, dry, hacking forms of **cough** hyoscyamus acts well as a sedative and may be substituted for opium derivatives or belladonna. Powdered hyoscyamus is a not infrequent constituent of the bronchodilator cigarettes employed by **asthmatic** patients.

The drug has also been used with gratifying results in severe **whooping-cough** and **laryngismus stridulus**. It is well borne by children. Fluidextract of hyoscyamus may be given in **acute** or **chronic bronchitis** in children in doses of  $\frac{1}{8}$  to  $\frac{1}{3}$  minim (0.008 to 0.02 c.c.) (Fischl), or the tincture in doses of 1 to 5 minims (0.06 to 0.3 c.c.) (Abt).

Hyoscyamus is often included in purgative preparations to prevent "griping." It is a constituent of the *pilule cathartice vegetabiles* (N. F.) (for the further composition of which see **COLOCYNTH**). It may be used similarly in various abnormal states of the intestine associated with colicky pain, and in **hemorrhoids** the following suppository has been recommended by Debove and Pouchet:—

R *Extracti hyoscyami*,  
*Extracti hamamelidis* ..... ãã gr.  $\frac{1}{2}$  (0.05 Gm.).  
*Olei theobromatis* .. gr. xlv (3 Gm.).  
 Ft. suppositorium no. j.

In **neuralgias** of various kinds hyoscyamus has been administered, but for most cases other more effectual drugs are available. Berner, in 1911, found that the extract of hyoscyamus materially increases the narcotic action of morphine and ethyl carbamate (urethane). Hyoscyamus may be employed with benefit in mild general **nervous excitement**; where the condition is pronounced, however, hyoscine will prove more effectual. Lambert temporarily administers hyoscyamus in combination with chloral hydrate and cannabis indica to relieve persistent **insomnia following withdrawal of morphine or opium** in addicts to these drugs.

Hyoscyamine has been considerably used for the purpose of facilitating and avoiding pain in the reduction of **incarcerated hernias**. The preparation most employed has been the so-called "amorphous hyoscyamine," which consists of the combined alkaloïds of hyoscyamus—true hyoscyamine and hyoscine. As this mixture varies according to the specimen of hyoscyamus from which it is obtained and is not recognized by the pharmacopeia, W. F. Waugh recommended that a definite mixture of atropine, 2 parts, with hyoscine, 3 parts, be used instead, the dose of this combination being  $\frac{1}{100}$  grain (0.0006 Gm.), one-tenth of which, together with  $\frac{1}{250}$  grain (0.00025 Gm.) of strychnine, is administered every five to twenty minutes until the desired effect has been induced. The same author found this mixture of value at times in **fecal impaction** and torsion of the intestine.

Good results reported from the following combination in **neuralgia**:  
 Extract of valerian, 1 part; hyoscy-

mine, 0.015 part. The formula is made up into pills, with suitable dosage, and one pill is given at 9 o'clock in the evening and a second a half-hour later; a third is given at 5 in the morning and a fourth at 8. Between the attacks quinine is administered. Bastie (*Revue française de méd. et de chir.*, No. 7, p. 161, 1904).

Amorphous hyoscyamine praised as an anodyne. It overcomes the painful spasms in the passage of **gall-stones** and **urinary calculi**, and gives almost immediate relief in all forms of **colic** without interfering with peristalsis. Usually as soon as the spasm is overcome the patient falls into a peaceful slumber, from which he awakens refreshed.

Hyoscyamine has a marked advantage over morphine for continued use, in that it has little, if any, tendency to habit formation. In **painful abdominal spasm** relief follows a dose of  $\frac{1}{250}$  grain (0.00025 Gm.) within half an hour, and four or five doses of like size keep the patient at ease throughout an entire twenty-four hours. Nitroglycerin and strychnine act as synergists to amorphous hyoscyamine. Like atropine, in acute conditions hyoscyamine should be pushed, in small doses, until the full physiological effect, manifested by dryness of the mouth and throat, is reached. G. L. Servoss (*Southern Clinic*, Dec., 1910).

Hyoscyamine is also employed by many ophthalmologists as a **mydriatic**, in place of atropine. The 2 grain (0.13 Gm.) to the ounce (30 c.c.) solution generally used also causes complete ciliary paralysis, and the action is advantageous in that it persists only six or seven days, as compared with nearly two weeks in the case of atropine. Hyoscyamine may likewise be substituted for atropine where the latter is not well borne in cases of **iritis**. De Schweinitz considers large doses of tincture

of hyoscyamus useful in **spasmodic heterophoria** (latent squint).

For a discussion of hyoscyamine the reader is referred to the heading **SCOPOLA AND SCOPOLAMINE**.

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**HYPERCHLORHYDRIA.** See **STOMACH, DISEASES OF: HYPERACIDITY.**

**HYPERCHYLIA.** See **STOMACH, DISEASES OF: HETEROCHYLIA.**

**HYPEREMESIS GRAVIDARUM.** See **PREGNANCY, DISORDERS OF.**

**HYPEREMIA, BIER'S TREATMENT BY.**—This method, introduced by Professor Bier in 1892, has for its purpose to increase, by causing hyperemia of a diseased area through mechanical means, the volume of blood *circulating* through it and thus enhance the bactericidal and antitoxic effects of that blood, to hasten the curative process.

[This method is quite in keeping with the trend of modern therapeutics. As Willy Meyer and Schmeiden state in their valuable work on the subject, "to increase this beneficent inflammatory hyperemia resulting from the fight of the living body against invasion is the aim of Bier's hyperemic treatment." This applies as well to inflammation, for if Bier's teachings are sound, according to the same authors: "we shall have to part with a number of time-honored views, up to the present time accepted as pathologic truths." They hold, furthermore, that "hitherto it was considered the physician's first duty to fight every kind of inflammation, since inflammations were looked upon as detrimental," and urge that "Bier teaches just the opposite: namely, to artificially increase the redness, swelling, and heat, three of the four cardinal symptoms of acute inflammation." Finally, they emphasize the fact that "the same rule obtains here as is generally applied in the case of infectious disease. There are very

few physicians today who would attempt to reduce the fever in such cases. We have learned to look upon this fever as one of the weapons of the organism in its fight against the intruder." S.]

The poultice, the hot sand bag, and similar long-tried measures owe their efficacy to the hyperemia which they induce and the benefit is proportional to the way in which they conform to the principles which Bier has found the secret of success in his methods of passive and active hyperemia treatment. The hyperemia has a curative influence only when it is the local concentration of healthy blood; hence measures to improve the state of the blood as a whole may be included in the term "hyperemia treatment." E. Joseph (*Therapie der Gegenwart*, June, 1913).

An important feature of the process is that the circulation of the blood be in no way interfered with, stasis being inimical to the results to be attained by means of the three ways in which the method is carried out: (1) By means of an *elastic bandage or band* which has for its purpose to retard the return of the blood to the heart by compressing the veins between the focus of inflammation and the heart, and suitable for diseases of the head, testicles, and extremities; (2) by means of *cupping glasses* of various sizes and shapes suitable for use upon the breast, back, pelvis, and body surface, where there exists a localized infection, an open lesion such as sinus, granulations, etc.; (3) by means of *hot air*, generated in wooden or metal boxes especially designed for the introduction of a limb, or application to a surface—the hips, back, etc.

Another feature of the treatment which requires especial care is the prevention of pain. Presence of the latter indicates that the constricting band or cupping glass is too firmly applied. It should not only be painless in application, but also relieve pain.

Experience has shown that when the two cardinal essentials: (1) free circulation of the blood in the inflamed area, and (2) absence of pain, are insured, the curative efficiency of the inflammatory process is

enhanced and that of resolution hastened. We thus obtain prevention of suppuration in a large proportion of cases; avoidance of surgical intervention, or at least substitution of a less grave operation for the severe one which progress of the local disorder might have rendered necessary: reduction of the duration of the morbid process while hastening process of repair.

The writer gives the Greek text of a passage in one of Hippocrates's works—cited later by Galen—and then gives a literal translation. Both read almost like a chapter from Bier's work on "Hyperemia." Hippocrates advises treating atrophy after immobilization of a limb, etc., by applying one or more bands to the sound part above, the constriction being tight enough to cause congestion of the blood in the part, but not tight enough to cause pain. After removal of the constricting band he orders the part to be rubbed and bathed so as to rejuvenate and promote the growth of the soft parts. The special point of this treatment, namely, that the constriction is not to be applied to the part affected, but to the sound region above, is duly emphasized, both in his works and in Galen's commentary, as also the fact that the constriction must never induce pain. He ascribed the benefit to the extra supply of nourishment from the blood thus retained in the limb. Fonstanos (*Jour. Amer. Med. Assoc.*, from *Grèce méd.*, Nov., 1908).

**TECHNIQUE.**—Having found Bier's method uniformly successful, Mr. Peter Daniel, Surgeon to Charing Cross, Metropolitan, and Gordon Hospitals, London, states that the unsatisfactory results often following its adoption when delegated to house surgeons and practitioners must be due, he holds, to want of familiarity with the technique and peculiarities attendant upon this plan of treatment. So clearly does he describe in Gaillard's *Southern Medicine* the various steps of the treatment, the causes of failure, and other features calculated to cut the practice of the physician that we prefer to give our readers Mr. Daniel's own version,



somewhat summarized, rather than purely descriptive matter which would not be of as great aid to them.

**Causes of Failure.**—As the success of the treatment practically depends upon ascertaining (1) the exact degree of hyperemia suited to each individual case, (2) the maximum duration of time the hyperemia should be maintained, it follows that a very close watch must be kept upon every case during the earlier applications of the bandage or suction glass. The failure to observe the *first effects* of the treatment *on the individual case* is the most usual cause of non-success.

The second great cause of failure depends upon the almost universal belief in the shibboleth that the vascular phenomena of inflammation are evil, and anything which tends to produce or increase any of the signs of inflammation cannot be good.

Unfortunately, pathologists still include in these phenomena the stages of stasis and thrombosis, and thus perpetuate the erroneous view that all the stages of inflammation are evil and to be combated at all costs. On the contrary, the first three stages are most essential, and without them resistance to infection is absent; they are manifest clinically by redness, heat, swelling, and almost every method of treatment which produces these clinical signs is used successfully in the treatment of diseases—fomentations, blisters, friction, massage movements.

**Advantages.**—Bier's hyperemia offers the following advantages: 1. It may cut short an infection or abort suppuration. 2. It always relieves pain, diminishes toxemia, reduces fever. This protects the body generally, and promotes sleep and recuperation. 3. If suppuration is present, it permits of successful treatment by means of less heroic measures, conserves bones, tendons, and joints, and obviates mutilating incisions, scars, etc. 4. It always favors an ambulatory method of treatment, in contradistinction to confinement to bed, as movements in inflamed parts may be painlessly performed while wearing a Bier bandage. 5. It shortens the stage of disease, and hastens convalescence. 6. It promotes absorption of inflammatory products and rapidly sets free necrotic tissue. 7. It is a non-terrifying

procedure, easy of application, and a most gentle manipulation. 8. It is not costly.

**Indications for Use.**—These are as follows: 1. Any infection, acute or chronic, above which a bandage can be applied, or over which a cupping glass may be placed, or to which dry, hot air may be applied. 2. Sequelæ and complications of infections, adhesions in joints, tendons, or other movable structures; chronic edema; sinuses and fistule. 3. Contractions due to trauma or paralytic lesions. 4. To aid healing and prevent infection in unavoidable operations under dirty conditions—crushes, gunshot wounds, etc. 5. To keep down exuberant granulations and thus promote rapid healing. 6. To inhibit recurrence from tissue soiling during the performance of operations, especially in tuberculosis. 7. To remove discharges from pockets. 8. To enable much earlier and painless passive and active movements in joints to be carried out. 9. To do away with plugging of wounds. 10. To clear up latent diseases. 11. To hasten the union of fractures.

Mild diabetes is not a contraindication, but diabetic furuncles and carbuncles require great caution. The suction cup should be large enough to rest everywhere on sound tissue. Here, as in all cases, the suction must never be strong enough to aspirate blood. Arteriosclerosis, as a rule, need not be regarded as a contraindication, but nervous diseases, tabes, alcoholism, etc., render the application of hyperemia treatment extremely difficult, as the disturbances in sensation deprive us of this useful guide. When the blood has been injured beyond repair by sepsis, hyperemia treatment is hopeless, but a sudden transient invasion of the blood and comparatively benign pyemic metastases are exceptionally amenable to it. Pyemic joint affections are the banner field for it. E. Joseph (*Therapie der Gegenwart*, June, 1913).

**Surgical Principles Involved.**—1. All pus must be given vent to. 2. But small, well-planned incisions suffice. 3. Never pack a wound with gauze, and it is rarely necessary to use a tube. If the edges of the

wound tend to heal prematurely, insert a layer of sterilized oil-silk between them. 4. If at the commencement of treating a wound or sinus the granulations are exuberant, cut them away and see the vent is free; they will not become exuberant under Bier's. 5. Avoid irritant dressings, and do not use antiseptics; employ asepsis. 6. Also avoid baths, wet dressings, and fomentations when there are open wounds. 7. Keep the surrounding skin dry and clean with alcohol, and, if necessary to preserve dryness and prevent contamination, then smear over it some thick, emollient sterile ointment. 8. Use the minimum of force; do not probe, squeeze, or swab unnecessarily, and never roughly. 9. When a Bier bandage is on, remove all other sources of constriction; a layer of sterile gauze or a sterile towel laid on the wound is the best dressing. The smaller the thickness of the dressing, the better. The ideal dressing is: Protection from contamination under a sterile towel; otherwise *nil*—free exposure to the air. 10. Where tendons are involved, as in whitlow, do not incise vertically over the front of the digit through the overlying tissues and tendon sheath (or theca), as this permits the tendon to rise out of its bed and **certainly die**; incise laterally.

**General Precautions.**—Certain precautions must not be violated. These are as follows: 1. Never bandage or apply pressure on diseased tissue, but on healthy parts. 2. Always bandage at such anatomical sites as enable all the veins from the diseased parts to be subjected to pressure. 3. Never produce pallor (anemia), coldness, or pain in any part. 4. Never produce any sensory changes. 5. Always remove every other source of constriction or pressure. Therefore, **remove** or **loosen** very freely all dressings. 6. The pulse beyond must never in the least degree be impeded. 7. Keep a constant lookout for new pockets or extension of disease. 8. If no local reaction appears, *i.e.*, in the diseased part, first apply heat for ten or fifteen minutes. 9. Do not fear increased swelling and edema in a part: they are essential. 10. Never reapply a Bier bandage until all the swelling and edema induced by treatment has disappeared. 11. Each case is a law unto itself.

The limb to which the constricting band is applied to induce local hyperemia must always feel as warm, if not warmer, than its mate. If the limb grows cold this is a sign that the blood is being shut off from the limb instead of collecting in it, and thus the opposite of the desired effect is realized. With small, peripheral infectious processes it is sometimes better to apply a second constricting band close to the lesion, in addition to the one higher up on the limb, as the hyperemia induced by the latter grows less and less toward the periphery, so that the lesion may escape its effect unless reinforced by a second, looser, constricting band closer to it. E. Joseph (*Therapie der Gegenwart*, June, 1913).

The modes of application, as previously stated, consist of (1) graduated constriction by means of an elastic bandage; (2) intermittent suction of specially constructed cupping glasses; (3) the use of hot, dry air. Each of these methods will now be reviewed in turn.

The instruments employed cannot be illustrated here, as there are now hundreds of them, each one destined for a different part of the body, but any instrument maker will send an illustrated catalogue of them on request.

**ELASTIC BANDAGE.**—The bandage should preferably be the special bandage without selvages (which produce injurious pressure), and not very strong, so that usually several turns of the bandage are necessary to attain the desired compression, rather than one turn of a strong bandage, as it is highly desirable to diffuse the pressure exerted by the bandage; hence several overlapping turns, beginning from below, are best; but in case of need, and generally when dealing with the head and neck, the scrotum and penis, or a digit, one turn may suffice. (Bier generally uses six to eight turns, each overlapping  $\frac{1}{2}$  inch.)

For the upper and lower limbs a bandage 2 inches to  $2\frac{1}{2}$  inches wide is necessary, for the neck  $\frac{3}{4}$  inch, for a finger alone  $\frac{1}{2}$  inch, for the scrotum and penis a thin-walled (*i.e.*, soft) rubber tube serves

best (the black rubber tubing formerly used for children's feeding bottles is excellent).

Children require careful observation, and bandages in proportion to their size and frailness; also it is invariably wiser to protect a child's skin by a layer of fine Saxony flannel or lint, and to gently massage the constricted zone after the bandage has been removed. As make-shifts, rubber rings serve admirably for small parts.

Before applying the bandage the practitioner should note: (1) the degree of prominence of any veins; (2) the color and temperature of the skin; (3) if there is a wound, the color of the granulations, and the amount and character of the exudation; (4) always feel for and note the arterial pulse; (5) any special peculiarities of the case; (6) ask the patient to observe the degree and character of the pain present.

**Tension of the Bandage.**—As to the degree of tension which should be exerted in any given case, it is quite impossible to say. One learns by experience and by observing the precautions formulated. It is best to start with a case in which there is an open wound or sinus, such as a whitlow; this should be carefully dried and a turn of the bandage applied above. In two to five minutes, if there is a definite exudation or moisture visible, the amount of pressure is *efficient for good*; if there is no visible exudation in two to five minutes the pressure must be increased, or another turn of the bandage taken, until exudation results. One must remember that if a bandage is to remain *in situ* for many hours one must not produce a copious exudation in a few minutes. This I think usually wrong, and likely to lead to that greatest of errors, "overdoing it."

Further, whatever the character of the discharge *previous* to the application of the bandage, purulent, sanious, or what-not, the exudation which appears from the granulations in from five to ten minutes will be, must be, serous—clear, yellow, sticky. The quantity of exudation soon decreases and in many cases entirely ceases, although the wound might have been previously discharging pus freely.

The tension of the bandage should be

successfully estimated at the first or second application and maintained at this throughout the treatment; errors of judgment, however, must be corrected at all times.

If there are obvious granulations a correct hyperemia is induced when they show a bluish or deep-red appearance.

In the case of lesions other than open wounds, such as a prick or other lesion likely to lead to suppuration, or if one fears infection therefrom, as in the case of a post-mortem prick, a bandage should be worn, and the tension is now estimated on general principles, *i.e.*:—

1. The compressing bandage or ring itself must never produce local pain (if this is really unavoidable its position must be frequently changed). 2. It must relieve any pain, throbbing, burning, felt by the patient in the injured part, within from five to fifteen minutes (often this is instantaneous).

Fingers should *not* be made "blue" on the application of a bandage. They stand in a class apart and react magnificently to Bier's, and should never be made so dusky as to lose the distinct red tint, except perhaps after many hours' treatment.

Cyanosis should *not* be produced in any part of the body as an *indication* of the degree of tension of the bandage. Blueness, as distinct from reddish blue, should only be present at the termination of the period of congestion. Thus, the color of the part beyond should, after five minutes, be only just perceptibly reddish blue, *excepting* those cases where the bandage is to be retained for a short period, say, an hour, when the color reaction should be better marked.

**Precautions in the Use of the Bandage.**—In any lesion of the upper or lower limb beyond the elbow and knee, except a terminal phalanx, the bandage must be applied to the upper arm and thigh; further, it should be applied well above the condyles, preferably near the axilla in the upper limb and just above the middle of the thigh. When a terminal phalanx is involved the base of the finger may be constricted.

Having observed the precautions previously mentioned, take a turn or two of the bandage. Note if the veins are now

fuller, or, if imperceptible before, are they visible now? Feel one. Is it too taut? If it can be fairly easily obliterated it is not; if, however, it feels incompressible, the bandage is too tight. At the same time ascertain the patient's feelings. Is the bandage irksome? Does the diseased part feel more uncomfortable? If the patient says he does not mind the bandage, that it is comfortable and does not obtrude on his sensations, and, further, if he says the diseased part is more comfortable, accept these points as the very best guide.

After a short time feel the limb. Is it colder at its extremity (allowing for exposure, etc.)? If it is, the bandage is too tight.

Is the skin slightly darker in hue and less pale? Is there any sensory disturbance?

Swelling and edema appear after an indefinite period, varying with the anatomy and laxness of the tissue of the part; in the scrotum and prepuce it may be considerable, but in a finger, or on the head and neck, it will and must be inconsiderable.

Above all things, avoid increased pallor, coldness, and any sensory changes. These must never result.

Thus, if the bandage is not irksome, if pain is relieved, if the veins are more prominent without being incompressible, if the limb retains its warmth (sometimes feels hotter), and, later on, some edema appears, and no loss of sensation occurs, the bandage is at a correct tension, and should be fixed by a safety pin, to be replaced later by a piece of tape sewn on to the last turn. Mark the turns of the bandage for future guidance, and see they correspond when replacing it.

In the case of the *head* and *neck* an elastic fillet  $\frac{3}{4}$  inch wide is made, encircling the neck once, to be worn as low down as possible. It may easily be worn unperceived under the collar in either male or female. After the correct degree of tension is ascertained a hook and eye, or a stud and buttonhole, fixes the turn.

If the neck is plump sufficient pressure will be exerted by the bandage on both the cutaneous veins and the internal jugular, as, owing to the contour of the side

and back of the neck, the fillet appears to sit most comfortably just where the trachea begins to sink, and sufficient pressure for comfort is taken off the trachea by the sternomastoids.

If there is but little subcutaneous tissue or the trachea is relatively prominent, a flat pad about the width of and fitting over the sternomastoids, made of layers of flannel (or soft felt) of sufficient thickness and sewn together, must be used under the fillet.

The sensation of being choked, and interference with deglutition, must never be pronounced; and as the wearing of a bandage is occasionally only possible at night, it must never prevent sleep; in fact, it *must not be irksome*. At first all patients tend to resent the sense of even slight tracheal compression, and complain of fullness in the head, but a little patience soon enables them to overcome these unruly emotional sensations.

If the bandage "rides up" two tapes may be sewn to it and passed under the axillæ. In this way, for postoperative purposes, abscesses, glands, and sinuses as low as the cricoid may be treated, and if unilateral a figure of eight round the neck and axilla may be used for glands even lower than this.

The external jugular or the temporal vein serves as a visible guide to the surgeon.

Similarly with *shoulder* and *upper-arm* lesions high up, the elastic bandage may be supplemented by a soft, wide pad placed over the situation of the subclavian or axillary vein, i.e., it may be placed above and touching the clavicle in the hollow of the root of the neck or below the clavicle in the hollow just internal to the deltoid, the bandage, which has a tendency to slip off the shoulder, being kept in position as follows: A soft scarf formed of a skein of wool (or other suitable material) loosely fitting the neck is worn, and through its bight the elastic bandage is passed; in addition, two tapes are fastened to the elastic bandage where it crosses the anterior and posterior axillary fold, and tied round the chest under the opposite axilla.

By regulating the loop of the scarf, the axillary tapes, and the tension of the elas-

tic bandage, the latter may be kept at any spot desired, and the resultant compression regulated by the principles already mentioned.

An Esmarch tube tourniquet—i.e., a soft, big-bore rubber tube—is often used for the shoulder, the axillary folds being protected by lint or wool.

The *hip* cannot be influenced by a Bier bandage.

In the case of the *penis* and *scrotum* soft-rubber tubing serves best, but a rubber ring may be improvised. The penis alone or the penis and scrotum may be constricted together for penile affections; the scrotum alone for testicular and scrotal affections.

If only the anterior one-third of the urethra or the prepuce and glans are involved, the penis is slightly pulled away from the pubis and the ring slipped on (I find suitable broad, flat rings difficult to procure), or the tubing is tied in place (see later).

( If the scrotum is to be included, the tube, 8 inches long, is placed on the bulb behind the scrotum, and brought round to the dorsum of the penis; here a piece of tape is laid, across the tape the two ends of the stretched tube are crossed, and the point of crossing tied by the tape. In an institution a bulldog clip may be used.

To treat the *testicles* the scrotum is gently pulled upon so as to form a pedicle, and the ring or bandage applied while so stretched.

If the bandage is placed on the penis alone the urethra beneath should be protected by means of a layer of soft material, but when the scrotum is included the latter serves this purpose; the scrotum should invariably be protected by a layer of lint (the pedicle may be formed by a turn of the lint).

The tension is estimated, as before, on general principles and by observing the fullness of the cutaneous veins; also by the relief afforded. The glans early becomes congested. In testicular affections considerable edema of the scrotum must be produced after some hours of constriction, else the benefit afforded by the bandage appears to be very small.

In the case of early gonorrhea the con-

gestion of the glans should be fairly marked, and the bandage may be worn for ten or eleven hours continuously, day and night, micturition not being interfered with.

Take care the pubic hairs are not caught up in the bandage, or free them.

On first applying, wipe off the urethral discharge and observe carefully that in a short time it becomes thinner in consistence and clearer, and in a good reaction a clear, copious mucoid exudation will appear in five to fifteen minutes. At the end of this time the turgidity of the preputial veins and the glans should have ceased to increase, and there should be neither pain nor discomfort, else the bandage is too tight. Should the bandage become irksome, or micturition be impeded, it must be loosened.

The most suitable drug treatment to combine with Bier's is a mixture containing:—

R *Hexamethylene-*

*mine* ..... gr. v (0.3 Gm.).

*Tinct. hyoscyami* ... ℥xx (1.25 c.c.).

*Aq. chloroformi*,

q. s. ad ..... ℥j (30 c.c.).

To be taken four times a day.

Also restrict the liquids so as to give the organ physiological rest, and never syringe.

General hygienic treatment and ample physical rest are required.

In posterior urethritis (superficial prostatitis) this method must be replaced by a suction glass to the penis and perineum.

In *breast* cases (abscess, sinus, interstitial and puerperal mastitis, etc.), if the organ is sufficiently lax and pendulous to make a pedicle, the bandage serves admirably, it being retained in place by tapes carried around the thorax and over the clavicle.

**Retention of the Bandage.**—As to how long the bandage should be retained; as a general guide: (a) The more *acute* the infection, the *longer*—i.e., the more continuously—the bandage is worn; the maximum duration is eleven hours out of every twelve, then one hour's intermission.

The intermission is partly determined by observing the length of time necessary to permit the whole of the *induced* swelling

and edema to disappear. Slight elevation may be utilized to facilitate its removal. Any time over an hour must be deducted, and it will be found in practice that ten hours is the longest time a bandage may be worn.

In some cases, after from four to eight hours, the patient cannot longer tolerate the bandage, although no other evidence for its removal may exist. A trial of a new position may be made, and, if successful, the full time may be taken, but usually it is wiser to remove the bandage, and either make the time and tension it was tolerated the orthodox dose for that case, or else slightly decrease the tension in future and observe its effect.

(b) The *more chronic* the infection, the *shorter* the application; this applies chiefly to tuberculosis. The minimum dose per diem is one hour, the average two to six hours, either continuously or at two or more intervals. Mr. Daniel's own custom with regard to tubercle is to apply a lesser degree of constriction than if the case were a suppurating or septic case, and to wear the bandage one or two hours two or three times a day, taking particular note of the pulse and temperature, as well as the other conditions, to guide treatment.

The sensations of the patient are most important, the relief of pain and the ability to permit slight passive movements while the bandage is *in situ* being most helpful both as guides and therapeutic measures. It is very seldom necessary to induce a well-marked color reaction in tubercle, but if it is sought the tuberculous area should be fomented or bathed in hot water for ten to fifteen minutes, or a hot-air douche given for ten minutes before applying the bandage.

Occasionally edema is easily obtained, and is of good prognosis.

It is with regard to tuberculosis that the most divergent results are obtained, and in which the individual factor of the practitioner tells most.

The removal of all carious teeth and the cure of suppurating foci are highly essential, while a richly nitrogenous diet should be insisted on, supplemented with raw meat juice three or four times a day, which will do more to increase the resist-

ing power of patients than the use of tuberculin.

Open-air treatment, especially the ambulatory methods which afford change of view, gives stimulus to the mind and the ability to seek and obtain relief from monotony, and which, with the muscular movements entailed, are the fundamental reasons why "open-air" treatment does good.

**SUCTION GLASSES.**—Bier's suction glasses are simply cupping glasses, suitably shaped and adapted, with a hollow stem for the attachment of a special device for aspirating the air, and thus producing suction.

The varieties of shape, size, and finish are now legion. In the case of very large glasses, enclosing whole limbs, and also occasionally on small glasses for treating the penis or fingers, rubber diaphragms or cuffs are fitted over the rims, and through a hole in the center of the cuff the limb is passed so as to secure an absolute air-tight fit; it may, indeed, be necessary to secure the cuff firmly to the limb by a turn or two of bandage.

For orthopedic purposes where contractures exist, and to effect movements in ankylosed or stiffened joints, a result which is obtained with wonderful freedom from pain, very elaborate glasses with interrupted spaces, or windows, covered in by strong rubber sheets (diaphragms), and containing intricate mechanical apparatus, are used; these, however, are too complicated to describe within the limits of this article.

There are two methods of producing aspiration:—

The simplest is by means of a rubber bulb attached to the hollow stem of the glass, the degree of aspiration, and consequently of suction on the tissues, being in proportion to the degree the rubber ball is pressed when the glass is applied over the diseased area.

The other method is by means of a suction pump (a thoracic aspirating pump) attached to the glass by means of strong rubber tubing. On the rubber tube a three-way stopcock is fitted, so that the degree of suction can be regulated to a nicety and the apparatus removed without discomfort or difficulty.

Special-shaped glasses are available for different parts of the body, and the rims are made so as to secure close apposition to the varying contours of the part, accurate apposition being a *sine qua non*.

Where the rim may, of necessity, have to rest on bone on one side and soft tissues on the other, pneumatic rubbers, similar to those on the face-piece of anesthetic apparatus, may be attached to the glass.

**Size of Glass.**—The diameter of the glass should exceed that of the diseased area, but it is not desirable that it be more than will easily embrace the diseased part, *i.e.*, the pressure of the rim must be exercised on healthy tissue.

In this connection it is necessary to see that the thickness of the rim is considerable, so as to diffuse the pressure, as the rim actually performs the same mechanical function that the elastic bandage does—namely, it compresses the nervous system, and what applies to the bandage applies equally to the glass.

**Degree of Suction.**—When a glass is applied under suction the tissues are drawn into it, forming a dome-like protrusion, reddish blue or mottled in color. Color reaction is always marked in this method, and indicates considerable venous obstruction, which, if long continued, would be injurious; hence the method of treatment is carried out *intermittently*.

If the suction is too great (or too suddenly applied) the skin may become a very dark blue and petechiæ may appear; also pain is experienced, and it is by estimating the degree of discomfort—*i.e.*, its absence—and never losing the reddish tinge in the skin that in a short time the practitioner arrives at an estimate of the correct degree of suction.

Real pain should never occur, but in very inflamed parts the feel of the suction may amount to discomfort, which, however, in a minute or two quite disappears.

(1) A moderate-sized "dome," (2) a reddish-blue color, and (3) an easily tolerated but definitely felt suction are the trio of signs one goes by. These are added to in the case of furuncles, open wounds, etc., by observing that the serum which exudes is *not* blood-stained or rapidly ceases to be blood-stained.

The dome of tissue should *never be, or become, pallid*, which, of course, indicates interference with the arterial supply (anemia). Pallor and Bier's are incompatible.

With certain open wounds so readily do the granulations bleed that a definite pink tinge in the exudation may be unavoidable, but as they become healthier this slight bleeding is more easily avoided.

**Application.**—If the glass is a small one, with rubber bulb, squeeze the bulb about half empty, apply the rim firmly on healthy skin over the diseased area, which should be as near the center as possible; gently relax the bulb, and note the dome of tissue as it develops.

If the suction does not produce pain, and the dome is a reddish blue, all is well. The size of the dome is not always a suitable criterion, as it varies with the density of the tissue and the type of inflammation present. The glass is allowed to remain on for five minutes and then removed. To take it off gently squeeze the bulb; the dome disappears, and suction ceases. The glass is at once cleansed by wiping it, and immediately placed in boiling water for one minute, then taken out and placed on a sterile towel to cool.

Three minutes after its removal the glass is reapplied.

Thus, suction is maintained five minutes, then an intermission of three minutes; repeated for six applications, the séance consists, therefore, of thirty minutes' suction and fifteen minutes' intermissions. But a slavish adherence to this dosage is unnecessary.

Treatment is usually carried out once daily, but under certain conditions it is wise to make three to six applications in the morning and again in the evening, the result of treatment and the physical condition and progress of the patient determining this question.

As both bandage and glass protect the body generally from toxemia, which is proved by careful note of the pulse and temperature during the after-treatment, a more frequent application of the glass with a slightly lesser degree of suction is preferable. The patient can easily be taught to carry out the evening or morning application.

With the larger glasses the pump expels the air while the glass is *in situ*, rapidity of suction being avoided, and an accurate degree of suction can with certainty be obtained; by gently opening the stopcock air is admitted at will, and thereby the pressure varied from time to time, or diminished if an excess of aspiration has been induced. The air is gently admitted also to remove the glass.

**Precautions.**—Certain details are important.

That of infection and reinfection comes first. By the fomentation method of treating furuncles and suppurating wounds it is unquestionable that the practitioner prepares the adjacent skin by *soddening it*; then there is conveyed to it virulent bacteria from the original focus, by spread of the discharge along the surface of the fomentation. Treatment thus perpetuates the original trouble; likewise with acne and other lesions of the skin. With a Bier glass similar damage may be done unless (a) the rim is broad and smooth, (b) scrupulously sterilized by boiling, and (c) the skin is protected from an exudation which may exude and contaminate its surface. This is best avoided by freely smearing the skin around the wound with an aseptic and sterilized unguent, preferably vaselin. The unguent also helps to procure a perfect airtight fit. It may be removed, if necessary, by ether and alcohol.

A vessel of boiling water must always be at hand.

**After-treatment.**—Experience emphasizes the avoidance of both wet dressings and antiseptics. Therefore, a *dry sterile gauze* dressing without any wool, and the minimum of bandaging, is best. If wool is essential on account of copious discharge it should not be a thick pad. Free circulation of air appears to me to be highly desirable, and if a patient can be so managed as to do *without any dressing at all*, the discharge being mopped up from time to time with a sterile swab, great benefit will accrue. Thus, a minimum of dressing material frequently renewed should be aimed at. At night a gauze dressing must be worn. Keeping the surrounding skin dry by the above measures, supplemented by occasional swabbing with alcohol, is an

excellent adjunct to the treatment of all wounds. Toward the later stages, or if it is essential for the patient to be about,—i.e., out of house,—the gauze dressing, or a dressing of some thick, non-irritating sterile ointment, spread on lint with a hole in the center for the discharge to pass through, covered by sterile gauze, acts very well. By sterile gauze is meant one free from antiseptics and sterilized by heat.

If an abscess is to be opened a small but *efficient* incision or puncture suffices, and the glass may be applied at once. The bleeding soon ceases, and the pus and minute sloughs are removed rapidly. Within a few days the discharge diminishes markedly, or even ceases, and healing is rapid.

To keep the orifice open: Do not pack with gauze, but pass a strip of sterilized oiled silk or rubber tissue between the edges of the wound. In case of large abscesses a free opening should be made, so as to obviate wearing a tube; healing takes place much more quickly under Bier's methods.

The question of boiling the rubber bulbs and tubing is to be treated on common-sense lines; if they are soiled, certainly they must be.

It is maintained that the physiological effect (hyperemia) of a suction glass extends to a depth of 2 inches and, therefore, can reach any point in the limbs and parietes and, also, certain viscera.

There is no department of physio in which either the bandage or glass will not be of service; medicine, surgery, and gynecology offer many conditions for their employment.

**HOT AIR.**—Hot air may be employed to induce hyperemia in two ways: 1. In a hot-air chamber. 2. As a hot-air douche.

Dry heat generated by a gas ring, a Bunsen or paraffin lamp, electric bulbs, a spirit lamp,—in fact, any form of flame,—may be used as the source of heat. This is conducted by a funnel of sheet iron or block tin placed over the flame, but raised above its level—i.e., with a definite interval between.

**HOT-AIR DOUCHE.**—To the end of the funnel is fitted a tube, 2 or 3 feet long, which gradually tapers to a nozzle, and



the hot air as it issues is directed to impinge on the part to be treated, the heat being regulated: (1) partly by the size of the flame; (2) partly by the diameter of the funnel; (3) partly by the size of the interval between the flame and the funnel; (4) but chiefly by the distance the nozzle is held from the skin.

The degree of heat desired is the highest the patient can bear without pain or burning. An intelligent tinman or blacksmith can easily make the funnel; the tube for douche purposes must be attached to the end of the funnel by a universal joint, so that the stream of hot air can be made to follow the course of a nerve or be otherwise moved about.

**THE HOT-AIR CHAMBER.**—This is made of wood, preferably free from resinous constituents, which might take fire or liquefy and burn the patient, and well seasoned. It should be too large rather than too small. In the ends are holes lined with felt, prolonged as flaps, which can be bandaged on the limbs.

The roof should be made as a lid, and contain a sliding shutter for ventilation and evaporation, especially the latter, as the limb perspires freely, and the chamber should be kept dry, else the moisture interferes with attaining a high temperature and dry air.

The funnel is let into one side of the chamber, and to protect the limb from the hot air impinging directly on to it, and to diffuse the heat, a partition suspended from the lid, but not reaching the bottom, should be fixed.

The toes and highest points in the box are especially affected by the heat, and it is always wise to wear a hood over the toes, made of thick flannel or felt, else they become extremely painful.

**Technique.**—To apply the treatment the lid is raised, the limb passed into or through the box, and the felt cuffs bandaged on; the limb must lie comfortably. The ventilator is opened very slightly. The lamp or Bunsen is now lit and then brought under the funnel, and not too close to it. The temperature must be raised gradually, but neither pain nor real discomfort must be produced.

*Burns are easily produced* either by contact with the wood, or when the escape

of moisture is not sufficiently free, and are not noticed when produced. Endeavor to ascertain the highest temperature which is best borne, and maintain it by regulating the flame, and its distance from the funnel, and the width of the ventilator.

Tallerman baths when available are ideal hot-air baths. The dose of douche is twenty to forty minutes daily, according to the effect upon the disease. It should be started and finished gradually.

In the hot-air chamber a longer time may be given if it is well borne. After hot-air treatment in the chamber the ventilator should be widely opened and the temperature gradually reduced, the limb well dried and not taken out too suddenly.

Hot-air treatment should *always be followed by massage* and the part swathed. Occasionally a short exposure to douche or chamber may precede a Bier bandage.

A little ingenuity only is necessary to devise boxes suitable to place over the body or hips and shoulders. A few electric light bulbs carried under a cradle well covered with blankets make quite a good chamber.

**Indications.**—The indications for hot air are: 1. The period of convalescence from acute processes and to remove the ill effects of inflammation, trauma, and operative measures affecting joints more especially. 2. Also the indefinite lesions classed under neuritis and neuralgia. 3. Any painful parts.

Mr. Daniel, in closing, warns practitioners not to use the hot-air methods as a routine in tuberculous affections.

To ascertain what physiologic changes accompany the beneficial effects of bakes, hot packs, etc., the writers made a series of studies on normal and arthritic persons. The bakes were given in the usual manner, lasting  $\frac{1}{2}$  to 1 hour, according to the rapidity with which the subjects started sweating. Study of the sweat from the forehead obtained before, during and after the bake showed an average pH of 7.0, 7.6 and 7.9 for normal persons and 6.6, 7.2 and 7.5 for the arthritics. During a bake there is a consistent and marked tendency for the reaction of the sweat to change

toward the less acid or more alkaline range, irrespective of whether it was acid, neutral or alkaline at the outset. This tendency was invariable among the normal persons and marked among the patients with arthritis. Administration of 10 to 20 Gm. ( $2\frac{1}{2}$  to 5 drams) of sodium bicarbonate was without influence on the reaction of the sweat in 5 patients with arthritis whose sweat was on the acid side of the blood reaction. R. Pemberton and C. Y. Crouter (Jour. Amer. Med. Assoc., Feb. 3, 1923).

**SPECIAL THERAPEUTICS.—Surgery.**—In this field disorders which tend to include suppuration stand out prominently among those in which the use of the Bier method has been praised.

Among the surgical disorders in which the method has been most useful may be mentioned: **Furuncles, carbuncles, abscesses, acute lymphadenitis, infected wounds and inflammatory processes, fistulæ, primary and metastatic parotitis, puerperal mastitis, arthrodial infections (gonorrheal arthritis, for instance), perforative wounds of joints, felon and tendinous phlegmons (palmar abscesses, for example), acute and recurrent osteomyelitis, erysipelas, infected wounds, compound fractures, inflammatory flat-foot, scoliosis, varicose veins, gangrene and frost-bites.**

Closely related to the foregoing are the various manifestations of **tuberculosis, osseous, glandular, tendinous, peritoneal, etc.**, all of which are benefited.

Results of treatment on this principle of 105 patients with **carbuncles, felons, phlegmons, infected wounds, lymphangitis**, and similar affections. Its chief advantages are the doing away with the necessity for large incisions, with resulting scars, and for tamponing, while it reduces the length of treatment and prevents serious functional disturbances in **joint and tendon-sheath affections**. It is indispensable, however, that Bier's directions should be closely followed, and that the application of the constricting band should always be closely supervised by the physi-

cian. Küttner (Münch. med. Woch., Bd. lii, Nu. 48, 1905).

In **mammitis** a broad-rimmed glass fits over the breast, and a vacuum is created with an air pump connecting with a cannula through the rubber stopper in the top of the cup or jar. When there is distinct fluctuation in the abscess it is opened with small incisions after local anesthetization with an ethyl chloride spray, and the glass bell is applied at once. The immediate relief of the pain in all cases of **mammitis** is one of the greatest advantages of this method of treatment. It aborts early cases and prompt recovery is the rule. Three weeks was the average duration of the 15 cases thus treated, including 13 of **puerperal infectious mastitis**. Klapp (Münch. med. Woch., Bd. lii, Nu. 16, 1905).

The treatment of frozen parts in 150 cases demonstrated beyond question the advantages of the various procedures. Superheated air acts most promptly and powerfully, and is especially effectual in chronic processes, but constriction hyperemia is best adapted for the acute cases. Ritter (Münch. med. Woch., Bd. liv, Nu. 19, 1907).

**Malignant furuncle of the face**, particularly of the upper lip, is usually treated by means of incision or excision; more rarely by the use of caustics. Owing to the great danger of thrombosis of the cerebral veins, many authors recommend expectant treatment. The writer, assistant of Dr. Bier, reports 12 severe cases of **furuncle of the upper lip**, and 24 cases of a more mild nature, in which the lower lip and other parts of the face were affected. All the cases were cured by the treatment in the course of four to six days. The technique of the treatment is as follows: An elastic band, 3 cm. wide, is applied around the neck as low as possible and fixed at the back by a hook and eye. It need only be drawn moderately tight, as stasis is easily produced in the neck with only a moderate amount of constriction. A compress

may be placed within the band. The band should be kept on from twenty to twenty-four hours. The inconvenience experienced soon passes off. The face becomes swollen, and especially the affected parts. At the end of from one to three days of hyperemia the inflamed area softens and suppurates freely, then the discharge diminishes, and is followed by the process of healing. Applications should be made each day, the duration being gradually reduced, till the inflammatory process is at an end. Keppler (Munch. med. Woch., Nu. 7-8, 1910).

The suction method acts well in circumscribed inflammation, such as **carbuncle**, **abscess**, and **bursitis**, and gives particularly good results in **mammary abscess**. It is also useful in obstinate **septic sinuses**. It acts less favorably, and in some cases prejudicially, in spreading inflammation. It gives good results in **gonorrheal arthritis**, but should be used with caution in joint suppuration. It is contraindicated in erysipelas, and is of uncertain value in acute osteomyelitis. It acts beneficially in **infected wounds**. MacEwen (Edinburgh Med. Jour., Nov., 1910).

No physician skilled in the technique would be willing to do without it now in treatment of **tendon-sheath phlegmons**, **mastitis**, **furuncles on the face**, and **carbuncles**, etc. **Tuberculous lesions** may require it to be kept up for years to be finally successful, and consequently it is foolish to commence it with persons who are unable to devote the necessary time to it. For **tuberculous joint lesions** the constricting band should be applied for two hours a day, drawn just tight enough to induce considerable edema, with possibly a slight livid aspect of the limb. No pain should ever be caused by the constriction; the prompt relief of existing pain is one of the great advantages of the method. **Tuberculous abscess** should be punctured and the contents aspirated with a vacuum cup, suction hyperemia be-

ing maintained in this way, with intermissions, up to a total of thirty minutes a day, until the abscess has entirely healed over; the constricting band type of passive hyperemia can be continued at the same time for two hours a day. **Lesions in the testicles and epididymis** are also amenable. E. Joseph (Therapie der Gegenwart, June, 1913).

**Internal Disorders.**—Various general diseases such as **acute and chronic articular rheumatism**, **arthritis deformans** and **gout**, **diphtheria**, **pulmonary tuberculosis**, **bone metastases**, following **typhoid**; **lumbago**, and **seasickness** have also been found to yield more or less satisfactorily to the hyperemia treatment, used in such a manner as to induce hyperemia in the area which bears the brunt of the disease. Various **neuroses**, **cerebrospinal meningitis**, **paresthesias**, **writers' cramp**, etc., are also stated to have been benefited.

In **acroparesthesia** congestive hyperemia improves the nutrition of the sensory nerve-endings distributed in the skin of the extremities; the nerves suffer in this infection from insufficient supply of blood caused by contraction of the blood-vessels. In **neuralgia** the blood-vessels undoubtedly play a certain rôle in the causation of a degenerative state of the peripheral nerve. Not all of the cases of the first series gave uniformly satisfactory results. Four patients made a complete recovery, 7 showed great improvement, 1 (tic of the neck) failed. The writer makes a further report on 6 additional cases of neuroses, treated with favorable results by the use of Bier's method. The cases are **acroparesthesia**, **writers' cramp**, **telegraphers' cramp**, **brachial neuralgia**, a **paroxysmal cramp**, and **paresthesia**. Alfred Gordon (Va. Med. Semi-monthly, Sept. 25, 1908).

The writer has been applying constriction or suction hyperemia as a routine measure in treatment of **gallstone** and **liver troubles**, **sciatica**, **leg ulcer**, and **asthma** during the last five years, and has been much gratified

with the good effects obtained. In more than 100 cases of gall-stone and catarrhal liver enlargement, the application of a large suction bell over the liver region gave almost immediate relief, the pains and the swelling of the liver rapidly subsiding. The effect is very striking in **gall-stone colic**, the whole attack being aborted by the action of the large cupping glass. Weidenbaum (Med. Klinik, July 31, 1910).

In the treatment of **felons** and **infected wounds of the fingers**, the writer found obstruction hyperemia to be more comfortable to the patient, and more beneficial as well, when the bandage was placed about the forearm than when about the affected finger. Suction hyperemia has given better results in such cases than has the obstructive type. S. W. Moorhead (Therap. Gaz., April, 1910).

Among all methods for the application of heat, the steam douche is most effectual. Excellent results obtained in 24 cases of disturbances in the liver or biliary passages, especially congestions and stasis, **cholecystitis**, **catarrhal jaundice**, **gall-stone** trouble, and **diffuse inflammation of the liver**. The steam douche put an end to the cramp of the vessels causing the colics and thus cures the pain. The pressure is about one atmosphere and a half, and he generally follows it with an alternating hot and cold fan douche. When there is persistent tenderness he applies a hot coil to the liver region through which water at a temperature of 45° C. (113° F.) is constantly running. His experience with the steam douche was equally favorable in 5 cases of **kidney-stone colic**. The steam douche was applied for half an hour and followed by a bath at 35° C. (95° F.). The steam douche frequently takes the place of and renders morphine unnecessary. The same principles have proved equally effectual in treatment of **motor** and **secretory gastric neuroses**, **nervous dyspepsia**, and **gastralgia**, **acute** and **chronic gastrointestinal catarrh**, and for **atony** and **constipation**. Hot

packs to the stomach region with a hot coil act as a specific for **nervous vomiting** or **dyspepsia** and **gastralgia**, but the steam douche proved more effectual in the other conditions supplemented by massage and exercises. Klug (Jour. Amer. Med. Assoc., from Deut. med. Woch., May 25, 1911).

Of all thermostherapeutic methods, superheated air, of a definite high degree of temperature, with sudden application and early cessation, as in the use of the writer's "oven bath," is alone capable of being so regulated, that it will cause a pronounced arterial flushing of the deep tissues through reflex stimulation with maintenance of vasomotor tone and consequent tissue drainage. The effect must be maintained for 5 to 10 hours by retaining the horizontal position and by avoiding physical effort and mental disturbance. An important principle is that heat relaxes spasm in muscle tissue and therefore promptly facilitates the arterial blood flow through a part, both by overcoming points of tissue constriction and by dilating the arteries. This tissue relaxation relieves pressure pain and favors local metabolism and excretion of detritus. B. S. Price (Amer. Jour. of Electr. and Rad., May, 1924).

**Ophthalmology, Otology, and Laryngology.**—The Bier method has been found useful in various inflammatory disorders of the eyes, especially in **acute dacryocystitis**, **parenchymatous keratitis**, **sympathetic ophthalmia**, **blepharitis**, **conjunctivitis**, and **stye**, and also in **progressive optic atrophy**. It proved helpful also as to **otology**, in some cases of **otitis media**, even with mild **mastoiditis**, though not in the chronic forms; in **rhinology and laryngology**, in **acute coryza**, **acute** disorders of the various **sinuses**, frontal, maxillary, etc., **atrophic** and **hypertrophic rhinitis**, **acute**, **chronic**, and **hypertrophic tonsillitis**. The reports, however, seem contradictory, though preponderating opinions favor the method.

Personal observations and experiments that the Bier method is worthy of trial in numerous inflammatory

diseases, **phlegmon**, **furuncle**, etc., **dacryocystitis**, **blepharitis**, the various forms of **conjunctivitis**, especially **phlyctenular**, and **trachoma**. Of diseases of the **cornea** it seems especially applicable in **ulcers** of whatever origin, perhaps also for the clearing of **pannus**, and in **interstitial keratitis**, in which condition the vascular formation would be furthered, a circumstance supposed to precede recovery. Hesse (*Centralbl. f. prak. Augenheilk.*, June, 1906).

Since the writer has instituted the suction douche treatment for **mastoiditis**, but 2 cases out of 12 have come to operation. In both of these cases after all tenderness, pain, and fever had subsided, and the patient had been discharged from the hospital, home treatment was neglected and in two or three weeks they came back with a violent return of the symptoms. In both cases, at operation, the mastoid cells were found infiltrated with pus and the sinus extensively covered with granulations. Both cases made a perfect recovery, which was assisted by dry cupping at each dressing.

By irrigating in the presence of a partial vacuum we increase all the desirable actions of the irrigating fluid and annul or diminish the objectionable ones. One notable result is the lack of the soggy, waterlogged appearance so common after the ordinary syringing. E. P. Fowler (*Amer. Jour. of Surg.*, Nov., 1908).

**Gynecology, Obstetrics, Urology and Proctology.**—The treatment by hyperemia has been advocated in *gynecology*, for the treatment of **chronic para- and parametritis**, **parametritis posterior**, and **dysmenorrhea**; in *obstetrics*, for that of **puerperal arthritis**, **puerperal mastitis**, and **deficient lactation**; in *genitourinary surgery*, for that of **acute gonorrhea** and its complications, **prostatitis**, **epididymitis**, **cavernitis**, **impotence**, **gonorrheal rheumatism**, and **genital tuberculosis** of the same organs. In *proctology* it has been found useful in **anal fissure**, **hemorrhoids**, and in **anal tuberculous ulceration**.

Glass speculum for this purpose, constructed by the writer, with which is connected a rubber tubing which can be adjusted to a syringe or air pump to secure the necessary vacuum. In cases of **endometritis** the secretion is not only drawn from the uterus—more abundantly at first than later—but the hyperemia evoked aids in restoring the endometrium to its normal condition. The writer also observed the disappearance of inflammatory bands in the posterior fornix. He also has had some success in the use of Bier's apparatus for dispelling a **mastitis** and for bringing about a more bountiful **milk supply** after labor. In gynecological work the instrument is used on alternate days for about thirty minutes. Eversmann (*Zentralbl. f. Gynäk.*, Dec. 2, 1905).

The writer has treated 60 patients with **buboes** by application of a cupping glass to induce suction hyperemia, and reports good results. The large cupping bell used fits over the region and can easily be applied by the patient himself. It is applied for twenty minutes every two hours, with or without incision. The pain of **gonorrheal joint affections** was always promptly arrested by constriction, hyperemia, combined with superheated air. In several cases of **genital tuberculosis** in young men remarkable benefit was obtained. Frank (*Jour. Amer. Med. Assoc.*, from *Med. Klinik*, May 24, 1908).

The hot-air method is beneficial in **chronic inflamed adnexa**, **pelvic exudates**, **chronic parametritis** and **perimetritis**, **contracted painful scars**, and **fixed malpositions of the uterus and adnexa** when resulting from **inflammatory processes**. It is contraindicated when there is fever, in pregnancy, in hemorrhage not of ovarian origin, in menstruation and hemorrhagic endometritis, and in advanced pulmonary and cardiac diseases. A. Stein (*Jour. Amer. Med. Assoc.*, Jan. 23, 1909).

In inflammation of the urinary passages with infiltration nothing

loosens up the tissues and promotes absorption so effectually as the application of local heat. Patients bear without discomfort a temperature of 55° C. (131° F.) in the urethra, and the catheter can be left in place at this temperature for twenty-five or thirty minutes. The relief of pain is marked, and under all circumstances a warm catheter can be introduced much easier than one at ordinary temperature. Some patients otherwise requiring local anesthesia before the catheter can be introduced readily bear the introduction of a catheter heated to 30° or 40° C. (86° to 104° F.), and the dilatation can be carried much farther with heated catheters. Frank (*Deut. med. Woch.*, Nov. 6, 1913).

**Dermatology.**—In diseases of the skin its use has been found helpful in **acute eczema, acne, sycosis, psoriasis, mycosis of the nail, alopecia areata, and lupus.**

Practically all chronic forms of skin diseases are benefited by the hyperemic treatment before applying local remedies. The action of ointments and lotions is considerably facilitated if a local congestion of the part is produced before they are applied. The most satisfactory results have been obtained in **psoriasis**, especially in some very old standing cases in which the lesions were very chronic and localized.

Some cases of **lupus vulgaris** have shown rapid improvement. **Acne**, both diffuse and local, reacted well, but required a considerably greater amount of congestion and more frequently repeated treatments.

In **eczema** and **seborrheas** a profuse perspiration is quickly produced, and after a few minutes the whole part is bathed in sweat. In other cases the ordinary sweat is replaced by a serous exudation. In some instances of **non-ulcerated lupus**, which as a class perspire very freely under the treatment, a blood-stained serum exuded after a short time, and for this reason the cases require to be very carefully treated and only for

very short periods at a time, one minute or so usually sufficing. Sibley (*Amer. Jour. of Dermat.*, May, 1911).

**Concomitant Medical Treatment.**—The benefit accruing from Bier's methods being admittedly due to the bactericidal and antitoxic functions the blood contains, Sajous urged in 1908 that, inasmuch as thyroid gland, iodine, or the iodides, or, again, mercurials in small doses, enhanced the activity of these defensive functions, they should be used simultaneously. This view has been sanctioned by practical experience, especially in all conditions in which suppuration was threatened.

The writer indorses Bier's recent statement in regard to the great advantage of giving internally from 1 to 8 Gm. (15 grains to 2 drams) of sodium iodide a day to supplement the local hyperemia. This wards off development of cold abscesses. E. Joseph (*Therapie der Gegenwart*, June, 1913). S.

## HYPERESTHETIC RHINITIS.

—**SYNONYMS.**—Hay fever; periodic paroxysmal vasomotor coryza; hay asthma; summer catarrh; autumnal catarrh; spasmodic coryza; idiosyncratic coryza; paroxysmal coryza; ragweed fever; nasal hydropnea; June cold; rose cold; peach cold; horse cold; cat cold; dust cold, etc.

**DEFINITION.**—A form of severe coryza, sometimes accompanied by asthma, characterized by periodical recurrences at more or less fixed intervals.

**SYMPTOMS.**—In some cases there appear, one or two weeks before the access, a mild coryza, heaviness about the brow, general malaise, chilly sensations, itching at the roof of the mouth, and eyes; but these manifestations do not always present themselves, the attack of hay fever beginning suddenly at precise dates—August 10th for hay fever; May 10th for "rose cold"—in many cases.

The disease occurs twice a year in those affected by both "spring" and "fall" pollens, but most cases have only one attack a year. "Rose cold" is somewhat shorter in duration than "hay fever," which usually lasts about six weeks. Subjects of the disease can usually point to the exact day, and sometimes the hour, of the expected attack.

The access usually begins with a sensation of itching in the nostrils, which soon becomes very intense, and causes violent and prolonged sneezing. A pricking, burning sensation in the inner canthi, followed by profuse lachrymation, may accompany this symptom, or constitute the first evidence of the attack. Very soon the nose becomes occluded through intumescence of its lining membrane, and respiration through it is practically impossible. A watery discharge appears, which soon becomes very profuse, and its strongly alkaline character causes it to irritate the nostrils and the upper lip, sufficiently sometimes to give rise to painful excoriations. Violent sneezing may begin at once, or occur when the watery discharge begins to trickle down along the intranasal walls, and the patient makes futile efforts, by immoderate use of the handkerchief, to clear the nose of the cause of obstruction and irritation. Chilly sensations, frontal headache, tinnitus aurium, loss of smell and taste, violent itching at the roof of the mouth, pain over the bridge of the nose, facial pruritus, and general symptoms, such as slight pyrexia, urticaria, disordered stomach, and flatulence, are among the possible accompaniments of this stage.

As the affection progresses, the

nasal secretion assumes more of a mucoid character, becoming at times mucopurulent. The conjunctiva may become greatly inflamed, and photophobia and marked chemosis follow, rendering, in some cases, a prolonged stay in a dark room necessary. Asthma may occur as a complication of the affection, or as its only symptom. It may present itself any time during the course of the disease; it manifests itself suddenly as soon as the irritating agent is inhaled. In the majority of cases, however, it begins a few days after the primary nasal symptoms have shown themselves, and as soon as these become marked, probably depending on the amount of pollen in the air and the rapidity with which it reaches the mucous membrane of the bronchi and smaller air passages.

Menstrual disturbances observed in 2 of 5 cases of hay fever. In 1 of these leucorrhea seemed to occur in lieu of the nasal hydrorrhea. Joachimovitz (*Zent. f. Gyn.*, Oct. 25, 1924).

**ETIOLOGY AND PATHOGENESIS.**—Attention was called by Sajous in 1885 to the importance of general adynamia as a predisposing cause of this disease. In a study of 40 cases he found that 35 per cent. had near relatives who presented a clear history of hay fever or rose cold, and 42 per cent. had asthmatic near relatives. The early history of these cases also pointed to considerable vulnerability to the diseases of childhood: 40 per cent. had had six of these diseases; 60 per cent. had had five. These disorders were whooping-cough, measles, mumps, chicken-pox, scarlet fever, and diphtheria or croup. A comparison of these 40 cases with forty subjects, taken hap-

hazardly, who had never suffered from the disease, emphasized this vulnerability of future sufferers; while the aggregate of the diseases of childhood in the latter was 189, in the normal subjects it was 92, less than one-half.

A number of authors have independently urged a similar underlying cause: Joal (1895) and Cartaz, for example. Fink holds also that "the patient is always neurasthenic." Guéneau de Mussy, as far back as 1868, attributed the disease to "arthritis," a synonym for our "gouty diathesis." Leflaive, Bishop, Grube, and others have also urged this view—which obviously harmonizes with Sajous's, the gouty diathesis being, to a certain extent, a manifestation of adynamia. Interpreted with the functions of the ductless glands as factors of the problem, this becomes all the more evident in that Sajous ascribes this diathesis primarily to inadequate breaking down of wastes by their secretions, including the leucocytic trypsin and the adrenal ferment, the end-result being the conversion of food nucleins into harmless, eliminable end-products. Inability to carry on this process may be actual, *i.e.*, due to hypoactivity of either of the organs of the adrenal system, or passive, these organs, though normal, being unable to provoke the formation of sufficient autoantitoxin to insure catabolism of the excess of wastes with which the lymph and blood are burdened when overeating is indulged in.

Two prominent features of the disease, which, under these conditions, initiate the disease, have long been recognized; its identity as a neurosis (Beard, 1876) and the fact that, dur-

ing a paroxysm at least, the nasal mucous membrane is oversensitive (Roe, 1883). The latter factor is so marked that many years ago Sajous suggested, in lieu of the faulty term "hay fever" (faulty in that the disease may be provoked by many irritants other than new hay), that of "hyperesthetic rhinitis," which has been accepted by many classic writers. But in this hyperesthesia of the Schneiderian membrane one may discern the external manifestation of a similar condition of deeper nervous structures, *viz.*, of the general nerve center to which the sensory impulses are transmitted. It is this central disorder which the gouty diathesis or the general adynamia (inherited or acquired through disease, we have seen) awakens, the center involved being rendered hypersensitive by the imperfectly catabolized, and therefore toxic, waste products which are ever present in the blood in this class of cases.

The sensitive center—a nucleus of the fifth pair—appears to be, according to Sajous, located in the pituitary body. Cyon had previously observed that after removal of this organ the nasal mucous membrane at once lost its sensitiveness, and that the most active stimulants, including ammonia, failed to elicit the least reaction: sneezing, lachrymation, etc. It would appear, then, that the nasal mucous membrane is oversensitive because the center which receives its sensory impulses—that of the fifth pair—is itself oversensitive, and the excessive sneezing, lachrymation, etc.—that constitute the symptom-complex of the disease (all complications, asthma, photophobia, etc., being the result of involvement of neighboring nuclei)



—are but exaggerated expressions of physiological functions.

We cannot include hay fever among the disorders incited by the toxic wastes in the blood of gouty subjects, since the vast majority of gouty subjects do not have hay fever. The immediate cessation of the attack when the patient goes to sea or to localities in which the disorder does not prevail also militates against this. Were the gouty or any other diathesis its exciting cause, hay fever would obviously occur regardless of locality.

Indeed, it has been definitely established by many observers that the exciting cause of "rose cold" and "hay fever" lies in the pollens. The wide distribution of these pollens has been well shown by the survey conducted by Koessler and Durham (Jour. Amer. Med. Assoc., April 17, 1926), in Chicago and its vicinity. Their studies combined a field and an air survey; the city itself was divided into 171 mile square blocks. Oil-coated microscopic slides were used in examining the pollens. The total of neglected land in Chicago amounting to 38 per cent. of the city's area, 40,000 acres within the city limits were producing nature's own selection of weeds. An average city lot (about  $\frac{1}{10}$  of an acre) of ragweed will produce 100 ounces of pollen in a season, *i.e.*, 60 pounds to the acre; this means hundreds of tons of ragweed pollen each season in Chicago. In this pollen survey, one of the most comprehensive that has been carried out,  $\frac{2}{3}$  of the pollen found on the slides was from ragweed,  $\frac{1}{5}$  from the grasses, and of the remainder chenopods were the largest contributors. Blue grass proved the most widely distributed and intensive pollen pro-

ducer of the grasses, while red top and orchard grass were about equal.

Ragweed pollen protein occurs in the milk of cows that have eaten ragweed tops some hours earlier. Such milk gives a positive skin reaction in high dilution in sensitive persons, and when ingested, brings on clinical hay fever in the upper respiratory tract within one-half hour. E. T. Hermann (Jour. Amer. Med. Assoc., Nov. 18, 1922).

The aeroplane used to test pollen density in the air. The writer found that during the pollinating season of grasses, ragweeds and other common hay fever plants, their pollen occurs in large numbers up to an altitude of 4000 feet, and in diminished numbers at 4000 to 6000 feet. From there up to 15,000 feet the pollens are relatively few. Unless precipitated by rain or descending air currents, pollen clouds remain in the air during the whole pollinating season of the plants which generate them, the fallen pollen being replaced by new pollen. The existence of these pollen clouds and their change of position due to the air currents explain, according to the writer, the increase of hay fever pollen during cold winds and after sunset. Scheppegrell (Med. Jour. and Rec., Feb. 20, 1924).

The plants chiefly responsible are those producing in greatest abundance a light, dry pollen which can be long held in the air. In Kansas City and neighboring rural districts the common producers of light pollen are: (1) Of the trees, box elder, sycamore, cottonwood, ash, hazelnut, black walnut, hickory and oak; (2) of the grasses, rye, blue grass, timothy, slough grass and orchard grass, and (3) of the weeds, small ragweed, giant ragweed, marsh elder, cocklebur, the pigweeds, spiny amaranth, water hemp, lamb's quarters, red sorrel, marsh marigold, hop, hemp, buckthorn and cattail. Plants which produce the greatest quantity of pollen over the longest season are most important. W. W. Duke and O. C.

Durham (Jour. Amer. Med. Assoc., Mar. 22, 1924).

In the section of the country about New York, the early or spring variety of seasonal hay fever (March to July) is usually due to the grass pollens, *e.g.*, timothy, June grass, orchard grass, red top, corn, and plantain. The tree pollens are occasionally factors, and tests should be made for the ash, hickory, oak, maple, elm, poplar, birch and pine, especially if the hay fever starts in March or April. Desensitization with timothy protects against the other grasses; aside from the author's clinical experience, Coca and Grove have proved that all of the atopens of June grass, orchard grass and red top are contained in timothy pollen. Plantain must be considered a separate factor, responsible for a small percentage of early cases. The late or fall type of seasonal hay fever is due principally to the common rag-weeds (*Ambrisia elatior* and *trifida*), the season extending from Aug. 12 or thereabout to the first frost. A. Brown (Med. Jour. and Rec., Mar. 3, 1926).

According to Flood and Coca, hay fever is an expression of local hypersensitiveness, and may be established spontaneously. The active pollen substances are not toxins. The antibody-like substances of human sensitization are not demonstrable in the blood of sensitive persons by any of the immunity reactions. They are present in the cells of the sensitive tissues. They cannot be increased artificially by the usual process of immunization. The mechanism of relief from vaccine therapy is like that of desensitization in experimental anaphylaxis. Walzer and Kramer have shown, however, that the blood of hypersensitive persons can produce a local passive sensitization in other individuals.

The writer was able to produce precipitins for ragweed pollens. Much

importance is attached to the preparation of the antigen. If anaphylactic sensitization to a single antigen is dependent on precipitin production, and if such production is conducive of greater ability to produce precipitins to heterologous antigens, we may have an explanation as to why there is multiple sensitization in human beings. Parker (Jour. of Immunol., Nov., 1924).

Study of the reaction of guinea-pigs which had been sensitized by inhalations of antigen (egg white and horse dander), in order to demonstrate that it is possible to render them anaphylactic. It was found necessary for the animals to be very highly sensitive, and the sensitizing substance must reach the mucous membrane of the lungs. The study was made because there has been considerable discussion as to the nature of the reactions reported as occurring in human beings, and to determine whether it is allergy or anaphylaxis which occurs in persons who are naturally sensitive to proteins. The reactions noted by the authors were anaphylactic in character. Alexander, Becke, and Holmes (Jour. of Immunol., Mar., 1926).

Dunbar succeeded in extracting from the pollen of certain grasses (maize, wheat, rye, etc.) a so-called "toxin" which, instilled in the eyes or nostrils of persons predisposed to hay fever, produced in these parts the characteristic subjective and objective symptoms of the disease. This substance, instilled in the eyes or nostrils of persons not predisposed, produced, in the great majority of cases, no symptoms whatever. But it certainly appeared as if there were instances of transition in which, although the persons experimented upon never suffered from typical hay fever, they were yet more susceptible to its influence than the ordinary run of people, while in persons suffering from hay fever the effects were as

variable in intensity as are the attacks of the affection itself, both with regard to the local and the constitutional symptoms.

The especial sensitiveness of the nasal mucosa to certain pollens has been attributed to specific physical and chemical properties, but this question is still *sub judice*.

Two theories concerning the manner of action of pollen grains in hay fever have been vouchsafed: the first, that they act as soluble toxins; the second, that they act as foreign proteins, inducing anaphylaxis in sensitized individuals. In this connection, Black and Moore (Jour. Amer. Med. Assoc., Jan. 30, 1926) have corroborated the findings of Grove and Coca to the effect that pollen extracts which are protein-free (the protein having been removed by dialysis) work entirely satisfactorily, thus apparently showing that the proteins, at least with pollens, have little or nothing to do with the process of desensitization. They found by intranasal testing that the specific substances do not run parallel with the nitrogen. During 1925 they tested an extract which had been prepared in June, 1924; the solution used was composed of 2 parts of glycerin and 1 part of Coca solution. This extract, qualitatively protein-free, proved as active on intranasal instillation as when prepared. Among 62 patients, treated with this ragweed extract, 38 were free of all symptoms; 14 had occasional mild symptoms, and 10 were little benefited. Thus, for practical purposes 83.9 per cent. were free of symptoms. The conclusion from these results was that the active substance in pollen is not protein in character.

The symptoms of hay fever which may be brought on at any time in certain subjects by riding behind a horse, are ascribed to the dander from the animal's fur. Emanations from lobsters and the hair of cats and dogs and other agencies may likewise produce the symptoms.

Hay fever seems to be met with greater frequency among brain-workers, professional men, clergymen, lawyers, merchants, etc. It may occur at any age, and seems to affect men more often than women. It is more common in the Northern than in the Southern States, and in low, flat countries, as a rule, than in the mountains. Yet the White Mountains, the Catskills, and Adirondacks, formerly thought to be free of cases, are no longer altogether curative to a certain proportion of sufferers.

Heredity seems to play a very important rôle in the etiology. Spain and Cooke (Jour. of Immunol., Nov., 1924) studied the familial occurrence of hay fever and bronchial asthma in 462 cases, all clinically hypersensitive with positive tests. The antecedent history was positive unilaterally in 236 cases, or 51.1 per cent., and bilaterally in 34 cases, or 7.3 per cent., thus giving a total of positive antecedent histories of 58.4 per cent. Included in the study were 115 normal individuals, representing 115 families, in which there was a family history in only 7 per cent. In 89 per cent. of the cases with a bilateral history the onset of symptoms occurred in the first ten years, while in those with a unilateral history only 31 per cent. developed in the first ten years. These observers estimate that 71.6 per cent. of all

those who present a bilateral family history will develop this hypersensitiveness or "atopy"—the name suggested by Coca,—while in the unilateral group probably 56 per cent. will develop it. In the 41 per cent. of their 462 cases which gave a negative history, such lack of history may have been due to ignorance of the patient as regards the hypersensitiveness of the antecedent or because contact with the specific substances had not occurred, or if it did occur, was so mild as to escape special attention. Spain and Cooke were unable to determine the exact nature of the inherited factor.

**TREATMENT.**—In certain cases what might be termed a pseudoform of hyperesthetic rhinitis is provoked by the presence in the nose or nasopharynx of polypi, exostoses, turbinal hypertrophies, etc. (Daly, 1881). These projecting morbid tissues, mainly by irritating the sensory terminals of the surface apposed to them, render hyperesthetic not only this surface, but also the center to which the sensory impulses are transmitted, that of the fifth pair. Such cases are often not only sensitive to many pollens, but also to many commonplace irritants. They are readily cured by properly executed removal of the morbid growths, but in such a way that no adhesions or synechiae are left between the apposed surfaces. **Cauterization of the hyperesthetic areas** caused by them, by the local application of **glacial acetic acid**, **chromic acid**, or **galvanocautery**, tends further to insure recovery.

Systematic application of **silver nitrate** solution, 30 grains (2 Gm.) to the ounce (30 c.c.), to the nasal vestibule advised, particular attention being paid to 2 spots, the first high up

on the outer wall and the other on the floor,  $\frac{1}{2}$  to  $\frac{3}{4}$  inch back from the orifice. Agar (Brit. Med. Jour., July 24, 1920).

Good results in 10 cases from small doses of **radium** or **X-rays** to the eyes and nasal mucosa once a week. The symptoms all subsided in a few days to 3 weeks, and in some cases failed to recur in succeeding seasons. Barcat (Bull. de l'Acad. de méd., June 13, 1922).

If, on examination of the nose before the hay-fever season, the turbinals are found covered with boggy swollen mucous membrane, **cauterization** should be done to reduce them by scarring. Another use of the cantery is to touch the mucous membrane lightly and destroy some of the nerve endings and so lessen the extreme sensitiveness present. This should be done over the turbinals on either side, and particularly on the septum anterior to the bony outlet of the nose. With a blunt probe other tender spots can be searched throughout the whole area. The writer is in the habit of doing this cauterization about the middle of May, thus allowing just sufficient time for healing before the season commences. Coke (Brit. Med. Jour., May 23, 1925).

Irrespective of any organic disorders of the nasal cavities, the disease may be arrested—at least for a time—by similar applications to hyperesthetic areas, the latter being detected by sweeping a flat probe gently over the mucosa, both of the septum and of the surfaces of the turbinals and of the floor of the cavities, the itching caused by this procedure being greatly increased when the oversensitive areas are encountered.

Such results are not always obtained, however; nor is the disease checked permanently in any but a very small proportion of cases. It has been suggested that beneficial



composed of 30 grains (2 Gm.) of **quinine** and 1 ounce of vaselin, are recommended by Fulton. **Insufflations of orthoform** have also been extolled by Lichtwitz. All these measures should only be regarded as palliatives, however; they serve to relieve stenosis, allay irritability, and control excessive secretion.

To hinder the pollen from passing onto the mucous membrane, the simplest means is a tube of **vaselin** with a long nozzle, out of which sufficient can be squeezed just inside the nose. This can be pushed further up by pinching the nose with the finger and thumb, assisted by sniffing it up. **Liquid petrolatum** or **olive oil** may be used very frequently in a coarse spray, to which may be added **adrenalin** and **menthol** or **cocaine**. For the eyes, instillation of a few drops of **cocaine**, 4 grains (0.25 Gm.), and **adrenalin** solution, 3 drams (12 c.c.) to the ounce (30 c.c.), will assist and, passing down the lacrimal duct, also allay the trouble in the nose. From an atomizer this may be sprayed into the nose and eyes. Comfort is gained by **dipping** the whole face into a basin of **cool water** at bedtime. If sufficient salt is added the eyes may be opened in it. Such a washing often allows the patient to fall asleep in comfort. Coke (Brit. Med. Jour., May 23, 1925).

Intense itching of the eyelids, especially near the lachrymal caruncle, sometimes causes severe suffering. This is markedly allayed by **flooding the eyes with hydrant water**, using for the purpose the top of a flower sprinkler attached to a rubber tube connected with the spigot. **Cold compresses**, *i.e.*, cloths wrung out of ice water, applied to the sufferer's forehead and face, and renewed as soon as they become "the least bit" warm, afford marked relief, according to Wolner, when kept up

constantly for about three hours, and off and on for about six hours. **Photophobia** is another annoying symptom—similarly due to dilatation of the arterioles of the fundus. **Blue or smoked glasses** tend materially to alleviate it.

**Active immunization** offers more chance for cure and relief than any other measure. Temporary removal to localities where the offending plant does not flourish is possible for a limited number. Those obliged to remain at home may, nevertheless, derive comfort through simple hygienic measures. Wearing **amber-colored glasses** and driving in closed automobiles may make trips outdoors more inviting. Women will not hesitate to wear **veils** and combine fashion with comfort. Flowers and dusts of all kinds must be avoided. Bedroom windows, kept closed during the day, will prevent the ingress of pollen. During sleeping hours, a screen of muslin, saturated with water, may be placed in front of open windows to admit fresh air. Vigorous exercise outdoors should be avoided, causing a larger amount of pollen to be inhaled. **Frequent washing of the hair** is advised as a means of removing the pollen grains which may have become enmeshed in it. **Avoidance of sudden change in temperature and of exposure to drafts** is of especial importance. Exposure in undressing or getting out of bed will cause a temporary cooling of the surface and a consequent paroxysm of sneezing. For the same reason, sensitive persons should guard against exposure to **electric fans**. Bernton (Jour. Amer. Med. Assoc., May 5, 1923).

The *internal remedies* indicated in this disease can be divided into two classes: those which, like the local remedies, tend to cause constriction of the dilated arterioles, and those which tend to counteract the predis-



etc. Renaud (N. Y. Med. Jour., June 15, 1921).

Hay colds warded off by administration of **peptone** before meals. Lermoyez and Pagniez (Bull. Soc. méd. des hôp. de Paris, July 22, 1921).

Marked benefit in 48 cases from **intravenous injections of sterilized freshly triple-distilled water** in doses of 1 to 1.5 c.c., averaging 6 doses to a case. Larger amounts provoke intensification of symptoms. Severe disease symptoms demand minimum dosage. Five c.c. should not be exceeded in one week. W. J. Schatz (Med. World, Jan. and July, 1923).

The **thyroid gland** (or **parathyroid**) plays an important part in (1) stimulating the calcium of the body or in (2) activating the artificial calcium and fixing it so that it is not immediately excreted. The writers used both local and general measures at the same time, however, and therefore could not ascertain to which one to ascribe the good results obtained in some cases. F. J. Novak, Jr., and A. R. Hollender (Jour. Amer. Med. Assoc., Dec. 15, 1923).

The **ultraviolet rays** may be beneficial, though further trials are needed to prove this point conclusively. **Calcium intravenously** probably acts as a sedative, giving temporary relief in many cases. There is little evidence that parathyroid feeding is of value. R. Sonnenschein and S. J. Pearlman (Jour. Amer. Med. Assoc., Dec. 20, 1924).

**Dunbar's pollantin** has been lauded by some clinicians.

An important therapeutic method is based on the sensitization to pollen or special protein as the cause of the disturbance. Where an inquiry into the patient's sensitiveness to pollens or various proteins is to be carried out, *skin scarification*, or the "scratch test," is generally availed of. In this procedure, a series of scratches, about  $\frac{1}{8}$  inch long and 1 inch apart, is made, after cleansing

with 40 per cent. alcohol, on the flexor surface of the forearm, preferably without drawing any but a mere trace of blood. A drop of decinormal (0.4 per cent.) sodium hydroxide is now placed on each scratch. A glass spatula or wooden toothpick is then dipped into the dried pollen or protein and rubbed into the scratch, a separate spatula or toothpick being used for each product tested. One or more of the scratches may be used as controls, to which only the decinormal sodium hydroxide solution is applied. Positive reactions should appear in from 5 to 15 minutes, but often the readings are made after the lapse of 20 to 30 minutes. A positive result is marked either by an urticarial wheal with surrounding erythema or an erythema alone, in either case distinctly larger than the control. Various manufacturers supply test outfits or separate diagnostic materials with which these tests can be conveniently made.

When the patient can be studied before the rose cold or hay fever season, a survey of his habitual surroundings should be made and the skin tests carried out with pollens that might be connected with the anaphylactic condition present. If, on the other hand, the attack has already started, a **vaccine** of the pollens most likely to be responsible should be started at once.

Sixty-three cases treated with **pollen vaccines**. Of 18 complicated with asthma, 11 were entirely relieved. Of the remaining 44, 17 were entirely relieved, 18 considerably relieved, 4 slightly relieved, 2 not relieved, and 3 not reported. The vaccines used were, in the spring, a mixture of pollens from red-top, timothy, rye, and orchard grass, and, in the fall, ragweed alone. The possibility of a concurrent bac-



terial infection should always be taken into account. A. P. Hitchens and C. P. Brown (Jour. of Lab. and Clin. Med., Apr., 1916).

Pollens known to cause the greatest number of cases of the vernal and the autumnal type of hay-fever, when extracted in 9 per cent. salt solution gave an antigen that deteriorated quite rapidly. The same pollen extracted in 66 $\frac{2}{3}$  per cent. glycerol and 33 $\frac{1}{3}$  per cent. saturated sodium chloride solution gave an antigen that has proved to be remarkably stable and potent and which remains sterile. Clock (Journal of Infectious Diseases, Oct., 1917).

Injections of **pollen toxin** can be intensified by the internal exhibition of **calcium chloride**. The initial dose should be estimated after the skin reactions have been obtained, and the doses injected should be slowly but progressively increased. K. Eskuchen (Deut. med. Woch., Feb. 18, 1919).

Results of desensitization treatment based on 330 cases of true hay fever, 123 of which had received the treatment for 2 or more years. (1) No improvement, 7 cases. (2) Improvement as compared with previous years, but showing, nevertheless, troublesome symptoms for a short time, 46 cases. These patients were not materially better than most cases treated in previous years by cauterization and general hygienic measures. (3) Very definite improvement, apparently beyond criticism, 59 cases. These include patients with a previous history of severe attacks who, under treatment, exhibited only slight symptoms, and patients with a previous history of hay asthma who went through 2 or more summers without asthmatic symptoms. (4) Patients who showed no hay fever for 2 or more years in spite of full exposure to pollen, 5 cases. J. L. Goodale (Boston Med. and Surg. Jour., Aug. 29, 1918).

Of 27 cases of hay fever diagnosed, 81.4 per cent. were due to sensitiveness to the pollen of the ragweed, while 18.8 per cent were due to a

similar sensitiveness to goldenrod pollen. Treatment with extract of the ragweed pollen did not appear to have any favorable influence upon the course of the disease or the severity of the symptoms in 12 cases so treated. Treatment with the **goldenrod pollen extracts** in 3 cases was apparently beneficial in 2 cases and markedly so in 1 case. Williams (Milit. Surg., Feb., 1920).

The reactivity of the nasal mucosa may be markedly reduced by **spraying the nose and throat with the specific pollen antigen**. In a series of cases the results compared favorably with those from subcutaneous injections. A combination of the 2 methods proved still more beneficial. G. M. Mackenzie (Jour. Amer. Med. Assoc., Mar. 18, 1922).

**Preseasonal pollen treatment** yields excellent results in seasonal hay fever, provided 5 or 6 treatments with a 1:500 dilution, or better, 2 or 3 treatments with a 1:100 dilution, of the pollen extract are given. If it fails, benefit sometimes results from treatment during the season with pollens or with **autogenous nasal secretion vaccine**. To determine the cause in perennial hay fever, the writer advocates routine cutaneous tests with the common food proteins, common pollen proteins, and domestic animal hair proteins. If these tests fail, examination of the nasal cavities and sinuses may show the cause. I. C. Walker (Ann. of Otol., Rhinol. and Laryng., Sept., 1922).

In 5 cases in which prophylactic injections and Mackenzie's nasal instillations failed, the patients could still be much benefited during the hay fever season by daily subcutaneous inoculations of 0.25 c.c. of a **ragweed pollen extract** containing 10 mgm. of protein nitrogen per 100 c.c. W. T. Vaughan (Jour. Amer. Med. Assoc., Jan. 27, 1923).

While it has been asserted that **co-seasonal** or specific pollen **treatment** during the season of fall hay fever is of little or no value, the writer re-

ports extremely gratifying results from a modified procedure in which the interval between the **pollen injections** is dependent upon the relief obtained, and is frequently lengthened as the dose given increases. The patient returns the next day if any injection fails to benefit, and is given a larger dose; otherwise, he returns only when the benefit begins to wear off. Thus, in one case 0.1 c.c. of a 1:10,000 dilution of pollen vaccine was first given, next day 0.2 c.c., 2 days later 0.3 c.c., and 6 days later 0.2 c.c. of 1:5000, with improvement after each injection and early disappearance of the hay fever. Five other illustrative cases are given. The initial dose should be the largest that fails to cause any skin reaction. G. T. Brown (Ann. of Clin. Med., Jan., 1925).

The average case will give a definite positive skin test to an extract of his offending pollen with a dilution as low as 1:500 or 1:5000, but not infrequently the sensitiveness is so slight that 1:50 will be negative and at times even 1:20. Symptoms in these cases are due to the reception of enormous doses of pollen by the natural channels. In some instances, indeed, treatment can be carried to the point of complete eradication of the huge positive skin test originally secured with the ordinary commercial 1:50 diagnostic extract, without the slightest benefit to the hay fever or asthma, which, however, will clear up if treatment is pushed to the use of the large, recommended doses of 1:20 extract. The writers consider no case negative to grass pollen unless 0.2 c.c. of 1:20 extract can be reached without reactions. From experience in their own district (San Antonio, Tex.), they believe seasonal history justifies prevailing pollen immunization even in the absence of positive skin tests. I. S. Kahn and E. M. Grothaus (Med. Jour. and Rec., June 3, 1925).

Study of an indirect method of testing for hypersensitiveness, made be-

cause of the difficulty of testing in some cases because of irritable skin, eczema, etc., which interfere particularly with the interpretation of the tests. In the writers' method, blood is taken from the suspected hypersensitive patient, and the serum from it injected intradermally, using as many sites as tests are to be applied (although the sensitized area can be used more than once provided a different antigen is used each time). They deem it advisable to allow 24 hours to elapse between the time of passive sensitization and the use of the various antigens. The results obtained showed, at least, the feasibility of the indirect method of testing. Walzer and Kramer (Jour. of Immunol., Sept., 1925).

In a paper published in the Journal of Immunology, March, 1925, Coca and Milford described the methods of collection of pollens, horse dander, feathers, hair and numerous food products. It is probably true that many of the failures in the past have been due to inadequate methods in preparing.

Five, or 4.3 per cent., of the author's hay fever and asthma patients proved sensitive to *plantain*. Three subjects of hay fever who were sensitive to plantain and given **preseasonal** and **seasonal treatment** obtained pronounced relief. Bernton (Jour. Amer. Med. Assoc., Mar. 25, 1925).

Report covering 234 cases of bronchial asthma. Of these, 63.4 per cent. had complete or nearly complete relief; 26.9 per cent., marked relief; 5.5 per cent., slight relief, and 4.2 per cent., no relief. Pollen reactions occurred in 39.7 per cent. of these patients and in the writer's experience desensitization was only possible by using **extracts of the pollen** to which the patient was sensitive, because of their high specificity. His antigens were prepared by the glycerin and salt method described by Clock. Rowe (Jour. Amer. Med. Assoc., June 20, 1925).

Hay fever treated by intradermal injections. In 29 patients the method was monotonously successful, there being complete relief or relief so near to it that the patient was comfortable and satisfied in every case. The initial dose was based on the reaction which occurred in 1 to 500, 1 to 5000, or 1 to 10,000 dilutions, and .05 c.c. was given as the initial dose, the dilution being that which gave a weakly positive reaction. The patient was instructed to note carefully the size of the local reaction. In the early cases 3 doses a week were given; treatment was given daily, except Sunday. The increase in dosage was according to tolerance, the attempt being to produce a local reaction about the size of the patient's palm, which reaction should begin to subside in 24 hours. When relief was obtained, the dose interval was doubled, but the increase in dosage was continued. After 3 or 4 doses the patient was instructed to return at the first sign of hay fever or at 10-day intervals if no symptoms occurred. Relief was proportionate, not to the quantity of pollen extract administered, but rather to the extent and vigor of the local reaction. The intradermal method is worth while for trial by those experienced in hay-fever work. E. W. Phillips (Jour. Amer. Med. Assoc., Jan. 16, 1926).

The reason for stopping treatment when the season opened has been that it was supposed that sufficient stimulation would be gotten from the pollen absorbed through the mucous membrane. But those who have studied this carefully know that this is frequently not the case. Patients who present themselves even late in the season or during the season can be given much relief by inoculation. In a small percentage of cases excessive dosage is responsible for the poor results; each patient must be individually studied in this respect. In 10 cases treated the results were perfect; in 66 cases, satisfactory, which means greatly or considerably relieved, and in 24, poor or unsatisfactory. Treatment is begun about 6 weeks before

the onset of the season. The first subcutaneous dose is based on the results obtained by applying different dilutions of the extracts which they contemplate using, the first dose being that which gives the least reaction. Subsequent treatment is given at 5 to 7 day intervals and the amount depends on the reaction which occurs from the previous dose, the dose not being increased if there is rather a pronounced ragweed reaction. The treatment is stopped when the patient remains free of symptoms at the time other individuals are having the disturbance. Rackeman (Jour. of Immunol., Feb., 1926).

Among the remedies which tend to counteract metabolic deficiencies, the most useful is desiccated **thyroid**, which acts by enhancing the catabolism of toxic wastes. It may be given in 2-grain (0.13 Gm.) doses twice daily for three days, then once daily only. **Strychnine**, in  $\frac{1}{50}$ -grain (0.001 Gm.) doses after meals, enhances the action of thyroid extract by stimulating the vasomotor center and increasing the oxygen intake. When the use of these agents is begun two or three weeks before the expected attack, its severity and duration are often reduced.

There is undoubtedly a percentage of the patients who have been treated with pollen extracts in whom only partial success resulted because the patient had a bacterial infection grafted on his hay fever. In such cases a **vaccine**, either **autogenous** or **stock**, may be of considerable help. The patients seen outside of pollen season who are having manifestations like hay fever may be sensitive to dust, feathers, hair, etc., and diagnosis may be made by the use of extracts of this material.

In the case of house dust it is al-

most always necessary to make an extract from the dust from the home. There is also a percentage of these patients whose symptoms are due to bacterial infection, and careful study of the organisms present and the use of **autogenous vaccine** will frequently benefit the patient, in many cases effecting a cure.

**Climatic Treatment.**—There are many persons who derive little or no relief from the ordinary methods of treatment. Such persons will do well if they seek temporary residence in an environment lacking in the various pollen which excite the paroxysms of hay fever, or, better, if they spend the hay-fever season in an ocean cruise. Certain rocky locations, bare of vegetation, have been sought and patronized by these sufferers. The length of one's stay should be until the first frost at home, when they can usually return with safety. The question of expense enters here.

**Surgical Treatment.**—Various operations have been suggested for the relief of hay fever, from the milder ones of **intraneural injection**, and **removing spurs and other obstruction**, to those involving **nerve section or resection**, with an idea of permanently abolishing sensation in the vulnerable localities.

New method of treating hay fever surgically, viz., by **section of the nasal nerve** as it emerges from the anterior ethmoidal foramen at the inner third of the supraorbital margin. The operation is done under local anesthesia by **novocaine** and **suprarenin**. In each of 3 cases complete relief was obtained. E. Blos (Deut. med. Woch., Dec. 8, 1910.)

In the operative treatment of hay fever by **bilateral resection of the anterior ethmoid nerve** the therapeutic

result is indefinite, because of the possibility of operative injury to the neighboring tissues.

In seeking the route of the centripetal irritation we must consider not only the N. nasociliaris, but also the Nn. palatini and nasalis post. of the second trigeminus and N. infra-orbitalis. The hay fever may also originate in the air passages or bronchial mucosa. Resection of the N. nasociliaris does not remove all reflex irritation; resection of the anterior ethmoidal foramen does not affect the nerve trunk, but merely one of its branches, namely, the N. ethmoidalis ant. The N. infratrochlearis is also unaffected. If improvement in the dyspnea took place after resection of the ethmoid nerve, the conclusion was that the condition was of reflex nasal origin. T. Albrecht (Deut. med. Woch., July 27, 1911).

#### **Intraneural Injections of Alcohol.**

—Stein, of Chicago, introduced this method in 1906. Following the suggestions of Schlosser, he has used alcohol, pure and diluted (50 to 75 per cent.), for the purpose, using only a few drops (10 to 15) in each injection, and injecting the nerves as near their central ends as safety and accessibility would allow, in most cases within the nose.

Injection of the nasal nerve at its point of entrance into the nose advocated. To afford immunity to all cases it is necessary to inhibit the action of the entire nerve-supply of the nose, which means anesthetizing both the anterior and posterior group of nerves. This is easily done by selecting the proper length and curve of hypodermic needle and introducing it near these nerves as they enter the nose.

For **injection of the nasal nerve** a needle  $2\frac{1}{2}$  inches long is required, whose point is entered at the antero-superior angle of the nasal cavity, against the inner surface of the nasal

bone, and near its distal end. The posterior group of nerves is reached by a needle  $3\frac{1}{4}$  inches long with a curve near its end of 45 degrees. This is entered in the neighborhood of the sphenopalatine foramen, which is located in the sphenothmoidal fossa, just above and to the outer side of the posterior end of the middle turbinal. Both nostrils are injected, requiring 4 injections, 2 for the anterior and 2 for the posterior groups. In some cases it may be necessary to inject only the anterior groups. The injections are made painless by a preliminary application of a local anesthetic solution. No serious ill results have been encountered. The injections had to be repeated from 1 to 4 times, covering the season of attack. O. J. Stein (*Laryngoscope*, Sept., 1908).

**Alcohol injections into the nasal ganglion** employed in 43 hay fever cases, with results varying from an amelioration such as to cause the individual to suffer but little discomfort, to complete relief. In only 3 cases was there complete failure. R. J. Payne (*Mo. State Med. Assoc. Jour.*, Aug., 1924).

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**HYSTERIA.**—Hysteria is an affection which occupies a peculiar though an independent position in our nosology. It is characterized by the facts that the symptoms are always of psychic origin, that they are always the result of suggestion received from within or without, that they are in their nature unreal and unsubstantial, that, though at times persistent, they come and go, are fugitive and shifting, disappear spontaneously or under persuasion, and finally that they always arise in individuals who are neuropathic and who are predisposed by their very make up to the affection.

The war afforded an opportunity for studying hysteria in men such as never occurred before, and the lessons learned can be applied to the elucidation of many of the problems presented by hysteria in civil life. The writer defines hysteria as a condition in which symptoms are present which have been produced by suggestion and are curable by psychotherapy. He regards the so-called physical and mental stigmata of hysteria as merely artifacts, usually produced by suggestion on the part of the examiner. There is no narrowed field of vision unless it is suggested by the method of examination. By conducting a simple examination for the field of vision in opposite ways on the 2 eyes of the same person 1 field can be made to show a progressive spiral narrowing while the other shows a progressive spiral widening. The same rôle of suggestion is equally important in the matter of the so-called hysterical anesthesia, no anesthesia being present unless definitely suggested.

Abnormal suggestibility is clearly a predisposing factor, but hysteria may develop in perfectly normal persons under suggestion sufficiently prolonged and powerful. A. F. Hurst (*Lancet*, Nov. 1, 1919).

It is of the utmost importance to differentiate hysteria from the other functional nervous disorders. Under the influence of the school of Freud and of his followers, there has been a tendency of recent years to confound the various functional neuroses with each other. Nothing could be more unfortunate from the standpoint of practical medicine. Diagnosis and prognosis alike become impossible. It is absolutely essential that hysteria should be differentiated from the following conditions. In the first place, hysteria must be clearly distinguished from the neurosis of chronic fatigue, *i.e.*, neurasthenia. Hysteria is con-

stantly met with without the presence of a single fatigue symptom, just as it is constantly met with without a single organic lesion. Again, hysteria must be clearly distinguished from hypochondria. In the latter affection there is a characteristic symptom-group in which the patient is dominated by an all-convincing sense of illness, the cause of which he usually refers either to his digestive tract or to his sexual organs. Such patients, it need hardly be pointed out, never betray either the psychic, the sensory, or the motor stigmata of hysteria. Further, we must differentiate hysteria from psychasthenia, the neurasthenic-neuropathic symptom-group which the Freudian school has especially confounded with hysteria. The phobias, the indecisions, the abouliias, the irresistible impulses of neurasthenic-neuropathic mental disease have no place in the symptomatology of hysteria; nor, on the other hand, do we find in psychasthenia the anesthetics, the palsies, the painful sensory stigmata, the paroxysms of hysteria. There is absolutely no relation between the two conditions.

What, then, is hysteria? If we examine a case of hysteria, we are at once impressed by the fact that the symptoms presented are, as already stated, of a mental origin. Thus we discover in a patient an anesthesia. If we outline the area involved, we find that it bears no relation either to the distribution of the nerves or to the spinal segmentations. Quite commonly the loss of sensation involves the hand like a glove, or a foot and leg like a stocking. Such a loss is, of course, not in keeping with any fact of nervous anatomy. Finally,

such a sensory loss may shift in distribution, may come and go, may vary in intensity. The only possible inference is that such a symptom is of psychic origin. This conception of hysteria has now fortunately taken hold firmly of the modern medical mind.

The French have elaborately studied hysteria, and it is due to Charcot, his pupil Gilles de la Tourette, and his followers that we today have an adequate conception of the affection, but it is due to Babinski that the fact of the origin of the symptoms in suggestion has been especially emphasized. Indeed, Babinski points out that many of the symptoms elicited are largely due to the examinations made by the physicians. That there is much truth in this position will become apparent as we proceed. The neuropathy of hysteria is inherent, and is part and parcel of the makeup of the individual, and is present from the very hour of his birth. Such individuals present an abnormal, a pathologic, susceptibility to suggestion, so that symptoms are grafted upon the patient's mind with the greatest ease. Occurrences in themselves utterly trivial and without significance may be followed by palsies of limbs, hemiplegias, convulsive attacks, paroxysmal seizures, and what not. At times the incident which precedes the onset of symptoms consists merely of a fright, there being not the slightest physical trauma of any kind, and yet the most massive hysteric symptoms may supervene. That normal persons do not react in this way need hardly be stated.

The fact is that the hysteria really pre-exists and is simply brought to

the surface by the suggestion of the fright or shock.

To show the rôle of suggestion in the development of the symptoms in hysteria, the experience of Babinski in regard to hemianesthesia is well worth recalling. Babinski found that, in testing 100 consecutive cases of hysteria for hemianesthesia, he failed to elicit the symptom in a single case, inasmuch as he carefully avoided suggestion. Babinski maintains that the sensory losses of hysteria are always the outcome of inadvertently made suggestions. He claims, for instance, that the reason hysteric hemianesthesia predominates on the left side of the body is because the physician, being usually right-handed, has the brush or esthesiometer in his right hand and naturally tests the left side of the patient first, thus suggesting the very hemianesthesia he is trying to discover. It is quite obvious that such a procedure will not and can not elicit the symptom of hemianesthesia in a normal individual, *i.e.*, in a person who has not the hysteric constitution. The normal individual repels, the hysteric individual accepts, the suggestion. It is this inability to repel harmful and painful suggestions which constitutes hysteria. This is, of course, true whether the phenomena which arise in the patient consist of anesthetics, of palsies, visceral disturbances, or other symptoms. Sometimes suggestion results in imitation. One hysteric patient may excite similar symptoms in another or indeed in a group of persons. At first such an imitation may seem purposive or voluntary, but later it may seem involuntary and even subconscious. Hysteria is, then, in a sense, contagious. Numerous instances of

the contagiousness of hysteria, *e.g.*, between young girls in school, might be cited. One patient presents the symptoms of hysteria and subsequently the same or similar symptoms make their appearance in others who happen to be susceptible. Some years ago Raymond presented at the Neurological Society of Paris a young woman suffering from hysteric hemiplegia with contractures. The history of the case was that the patient and her husband, recently married, had spent their honeymoon at the seashore, and it so happened that in their daily walks they met an old man suffering from hemiplegia. No comment was made by the young woman, but some time after returning to her home she began to walk as did the old man, while her limbs also assumed the positions of fixation and contracture. Obviously such a result as this could only have occurred in a neuropathic individual, *i.e.*, in an individual in whom the hysteria had previously and potentially already existed.

In addition to the pathologic vulnerability to suggestion, the psychic makeup of the hysteric subject presents certain other features in keeping with this feebleness of resistance. Thus, just as impressions suggestive of various symptoms are followed by an undue reaction, so does the patient present an undue or pathologic reaction to emotional stimuli. That the hysteric patient laughs and cries more readily is a fact of common experience. Often, too, the actual emotion experienced is less keen or profound than the outward signs would suggest. Indeed, emotional instability and exaggerated emotional expression are symptoms of everyday

observation. Similarly the hysteric patient is more readily frightened than is the normal person, and the degree of fright and its outward manifestations may not only bear no relation to each other, but may be out of all proportion to the cause of the fright, which not infrequently is trivial; indeed, at times, practically non-existent.

**SYMPTOMS.**—The symptoms of hysteria may make their appearance in childhood, at puberty, during youth, and less frequently may be delayed until the third or fourth decade of life. However, the late appearance of hysteria is rare. Usually cases of late oncoming hysteria—if the history be carefully studied—reveal the undoubted presence of the hysteria at earlier periods of life. When once established, manifestations of hysteria may be observed at all ages, even in middle age and old age. The writer's experience, based upon many years of observation both in the hospital and in the community at large, justifies the belief that the symptoms of hysteria never make their appearance save in an individual in whom the hysteria has pre-existed. In other words, the exciting incident—if there be one—merely serves to bring the slumbering affection to the surface. Among the incidents other than suggestion which may lead to the manifestations of the symptoms of hysteria are, as already indicated, fright and emotional experiences.

Hysteria bears no relation to mental strain or overwork, nor does physical shock, unconnected with fright, play a rôle. For instance, accidents occurring during sleep do not elicit the manifestations of hysteria. Visceral affections, it need hardly be

added, are not a cause of hysteria, and this is true especially of pelvic disease. The name hysteria has its origin in the supposed relation between the uterus and the nervous phenomena, an idea which, though without any foundation, has persisted until relatively recent times. It is unnecessary to point out that hysteria is uninfluenced by pelvic operations, and finally that it occurs in the male as well as in the female sex.

While all of the symptoms are of mental origin, it will prove convenient to divide them into sensory, motor, visceral, and purely psychic disturbances.

**Sensory Symptoms.**—The disturbances of sensation may present themselves in the form of loss or diminution, of excess, or of a change in quality, *i.e.*, there may be present an anesthesia or hypesthesia, a hyperesthesia, or a paresthesia. Being psychic in origin, these sensory phenomena are characterized by the fact that they bear no relation to nerve distribution or to spinal segmentation. Thus, a patient may present an anesthesia of a hand, investing the latter like a glove; such an anesthesia is spoken of as a glove-like anesthesia, and obviously bears no relation to the facts of nervous anatomy. A similar loss of sensation may be present in the foot and leg, and is then spoken of as a stocking-like anesthesia. Again, it may involve a small segment of a limb. Thus, it may extend from the wrist to the elbow, the parts above and below being entirely normal in their responses. In such an instance we speak of a segmental anesthesia. It may, on the other hand, be limited to an irregular patch on the trunk, limbs, or face. Such an



instance is spoken of as geometric anesthesia or islet-like anesthesia. Here again it is, of course, apparent that we have to do with an anesthesia that is independent of spinal segmentation or nerve distribution. It must, therefore, be psychic in origin, *i.e.*, we must look for an explanation to some disturbance of the cortex.

Not infrequently a sensory loss involves the entire half of the body, thus constituting a hemianesthesia. More rarely it involves the entire body or almost the entire body. Such a hemianesthesia is apt to be defined by a sharp line in the middle of the body, but, as neither such a sharply defined hemianesthesia or a so-called total anesthesia can be referred to definite anatomic lesions, we are again forced to refer them to a psychic origin. The sensory losses of hysteria usually involve all the qualities of sensation; for example, touch, pain, and temperature, but in certain rare instances a dissociated or partial sensory loss may occur, *i.e.*, the patient may claim that he feels the touch, but can no longer recognize heat or cold or pain. The most common finding is that of a partial sensory loss to all forms, *i.e.*, a lowering of sensation to heat, cold, pain, and the tactile sense. Such a sensory loss is termed a hypesthesia. Instead of a sensory loss as just stated, there may be an exaggerated sensory response, *i.e.*, a tenderness, a hyperesthesia, may be present. Such a hyperesthesia may be widely diffused, for instance, over the back or over the abdomen. More frequently, however, it makes its appearance in small spots, isolated and rounded or oval in shape. If such an area be touched, especially when the patient has full knowledge

that an examination is being made, the patient's reaction may be excessive, *i.e.*, he will react as though the area touched were excessively sensitive or painful. This hyperesthesia, whether diffused or occurring in small areas, is characterized by one remarkable fact, and that is that if the finger of the operator comes lightly in contact with the supposedly sensitive area the patient, as already intimated, reacts excessively; acts as though he were suffering acutely. If, however, the finger or the hand is allowed to rest upon the supposedly painful area and deep pressure is gradually made, all painful response ceases, *i.e.*, the pain complained of is referred by the patient to the *surface* only. He does not refer it to the deeper tissues. Further, he becomes entirely unconscious of it when his attention is fixed upon some other portion of his body. If, for instance, a painful area be found to exist over the spine and the hand allowed to rest on this area, at the same time that the patient's attention is skillfully drawn to the front of the chest, to the abdomen or elsewhere; or if the physician, his hand still resting upon the tender area over the spine, proceeds to auscultate the heart and in his conversation directs the attention of the patient to the heart's action, no response is made by the patient whether the supposedly painful area is pressed upon or not. In other words, the pain and tenderness of hysteria, like the other symptoms, present an appearance of being alike unreal and unessential.

Areas of this so-called painful hyperesthesia may make their appearance upon any portion of the trunk or limbs, *i.e.*, upon any portion of the

body, in accordance with the spontaneous autosuggestions of the patient or in accordance with suggestions from without, such, for instance, as may have their origin in a blow upon the back. They occur, curiously enough, relatively frequently in certain situations, such as a small oval area over the ribs just below the mammary gland and another small oval area immediately over the groin. Curiously enough, too, these painful areas are found more frequently upon the left side of the body than upon the right and possibly for the same reason that, as Babinski points out, hemianesthesia is also found on this half of the body. When found below the breast the area is sometimes spoken of as inframammary tenderness, and when found over the groin, as inguinal tenderness. This so-called inguinal tenderness at one time gave rise to much confusion. It was early termed ovarian tenderness, but experience soon showed that it had nothing whatever to do with the ovary. Time and again, in years gone by, the ovary was removed and yet, as a matter of course, the tenderness persisted. A brief investigation will always in a given case show the extremely superficial character of this inguinal pain and demonstrate that it is limited to the surface of the skin. The patient having been placed in the position for gynecologic examination, the index-finger of the left hand is placed immediately upon the painful spot on the groin. The index-finger of the right hand is then inserted into the vagina and its tip brought immediately below the tip of the index-finger of the left hand. Slight pressure between the tips of the two fingers now causes the patient to

flinch and complain of pain, just as she does when the area of inguinal tenderness is merely pressed upon on the outer surface. Other portions of the abdominal wall are then in turn included between the two index-fingers, and it is quickly demonstrated that the painful area is limited entirely to the abdominal wall. The finger within the pelvis can manipulate freely the uterus and the adnexa without causing the patient to give any evidence of pain. Moreover, the external and extremely superficial character of the pain can be still further demonstrated by picking up a fold of skin over the groin between the thumb and forefinger, when the patient at once complains of the pain.

Other areas in which hysteric pain and tenderness are relatively frequent are the skin over the tips of the spinous processes, the inferior angle of the scapula, the small of the back, and the scalp; sometimes an entire limb is thus affected, though more frequently the tenderness exists in isolated patches over the limbs and trunk. Sometimes it is the skin over the very tip of the coccyx which is the seat of the tenderness. When these areas are found upon the scalp, they are usually so small that they can be covered by the finger-tip, and are usually associated with a sensation of boring pain or as though a nail were being driven into the skull and, indeed, this symptom has given rise to the term, now no longer much used, of *clavus hystericus*.

No matter in what portion of the body the pain may be located, it is never associated with signs of organic or visceral disease. It is of special importance to bear this matter in mind, for occasionally the hysteric

painful area involves the nipple and adjacent portions of the mammary gland. Indeed, the pain complained of is often so great that the patient will demand an operation for the removal of the breast. Such a breast reveals, of course, nothing abnormal to examination, and in addition there are usually present numerous other evidences of hysteria, such as numerous painful spots or areas elsewhere and without relation to other organs or viscera; usually, too, there are the mental symptoms and other stigmata of hysteria, still to be considered.

Patches of painful tenderness may also be found upon the various mucous membranes, more especially upon the mucous membranes of the vagina and of the rectum. When present in the vagina, they may be limited to small areas which upon inspection reveal no change in appearance to the naked eye nor to any other examination. Sometimes the tenderness is diffused over the vagina as a whole and even shared in by the vulva. Such symptoms are usually associated with vaginismus, the patient declaring that it is impossible for her to have coitus because of pain and spasm. The purely psychic origin of vaginismus is well illustrated in an instance observed by the writer in which a young woman suffering from hysteria developed this symptom, during the continuance of which she refused to receive her husband. She was visited by a sister, also a young married woman. The patient's recital of symptoms was followed, in the sister, almost immediately afterward by an attack of the same symptoms, and the second patient likewise for a time refused to receive her husband.

At times patches of hysteric tenderness make their appearance in the rectum, the patient complaining excessively whenever the bowels are moved. At other times they make their appearance in the mouth or in the throat. It is characteristic, of course, that the most minute examination fails to reveal anything wrong. It is probable that in anorexia nervosa, a symptom still to be considered, painful areas make their appearance upon the mucous membrane of the stomach, the patient insisting that she has pain whenever any amount of food, no matter how slight, has been taken. Not infrequently too a hysteric patient will complain of pain in a joint. The patient will hold the joint in a fixed position and will complain of pain when attempts are made to move it. It was at one time thought in such instances that painful tenderness made its appearance upon the synovial surfaces, but there can be no doubt that the painful tenderness is limited purely to the skin covering and surrounding the joint, that it is a purely cutaneous symptom and has nothing whatever to do with the joint structures. Quite naturally painful hysteric joints most frequently arise in the lower extremities, due to the more frequent incidence of trauma and of fatigue in these members.

**Motor Symptoms.**—When we turn our attention to the motor phenomena of hysteria, we find that in given instances the patient believes that an extremity is paralyzed, or, instead of paralysis being present, there may be spasm of the muscles, fixed contractions, or there may be tremor or incoordination of movement. Like the sensory phenomena, the motor phe-

nomena cannot be referred to any organic lesion either, *i.e.*, they cannot be explained by any of the known facts of anatomy. A paralysis, like a sensory loss, may be limited and may involve merely a portion of a limb. It is never limited to individual muscles or to a group of muscles; thus if the arm be paralyzed, both flexors and extensors are involved. It may involve homonymous portions of the body and thus give rise to a paraplegia, or it may involve one-half of the body and give rise to a hemiplegia. Very rarely a general paralysis, involving both sides, is observed. The palsy is most commonly flaccid, though at times spastic in type. It may vary from a mere weakness to a total loss of power. As a rule, the tendon reactions are more pronounced than in the non-paralyzed limbs. The skin reflexes appear to be diminished and at times are altogether lost. Usually the nutrition of paralyzed muscles remains unaffected, but in cases of long duration some diminution in volume may be observed, although a true degeneration of the muscles never occurs. An electric reaction of degeneration is, therefore, never present.

When spasticity is pronounced it may give rise to a marked fixation or contracture. One of the most remarkable facts associated with hysterical paralysis is that the paralyzed limb is usually also anesthetic. For instance, if we examine a hysterically palsied arm, we find that the arm has also lost its sensation. In other words, the arm is cut out of the psychic makeup of the patient in its entirety; it is elided from the field of consciousness, both as regards motion and sensation. This association of

anesthesia with paralysis in hysteria is an almost constant finding and one that at once determines the nature of the paralysis. Sometimes we notice that a paralyzed area is somewhat edematous or that there is a bluish or mottled discoloration of the skin, a condition which the older French writers spoke of as "blue edema." This blue edema, which is occasionally met with in parts that are not paralyzed, may persist for a variable period; it may come and go. Usually it is not very marked. Hysterical paralysis may come on quite suddenly. It may come on suddenly as a result of a shock or trauma or it may begin as a slight weakness and gradually grow more pronounced until it becomes marked or complete. The effect of trauma is, as already indicated, most variable. A trivial tap upon a limb may result in a complete paralysis, while a severe destructive injury, involving it may be bones, joints, muscles, tendons, or nerves, may not be followed by any hysterical reaction whatever.

Hysterical paralysis is, as just stated, very variable in duration. Sometimes it is very persistent; especially is this the case when it has existed for a long time and when the association in the patient's mind with the supposed cause of the paralysis—*e.g.*, trauma—cannot for the time being be broken up or dispersed. This is noticeably the case in the hysterical palsies and other hysterical symptoms which make their appearance in predisposed individuals after railroad accidents. Here the palsy persists until the claim is disposed of, no matter what form of treatment may be adopted. The patient's arm, for example, remains paralyzed until the

case is actually settled, that is, the money actually paid over. Physicians are then no longer consulted and the paralysis soon disappears.

The palsies of hysteria, as already stated, point unmistakably to a mental origin. Thus, the hemiplegia presents features which enable us to distinguish it at once from organic hemiplegia. The arm is most frequently flaccid or nearly so; at least, it does not assume the position of secondary contracture usually met with in organic hemiplegia. Again, the paralysis is usually most marked in the leg, which is also usually somewhat rigid, but the latter is dragged in walking as though it were dead and absolutely helpless or, curiously enough, it is shoved in advance of the patient as he walks; the gait only superficially resembles that of organic hemiplegia. Further, the muscles of the face are never paralyzed. There is never any involvement of the lower half of the face, as in organic hemiplegia, and a total palsy of the face, such as is met with in Bell's palsy, likewise never occurs. The tongue at times deviates when protruded, but it always deviates not to the paralyzed, but to the sound, side, the reverse of that which takes place in organic ipsilateral hemiplegia. Again, the palsy in hysteric hemiplegia is equally marked in all of the segments of the limbs. In organic hemiplegia we know that this palsy, like the sensory loss, is emphasized or exaggerated in the distal portions of the extremities and less marked in the segments proximal to the trunk.

Hysteric paraplegia not infrequently occurs, but it is, as a rule, readily differentiated from organic paraplegia. If the patient with an

hysteric paraplegia is still able to walk, we find that the gait is spastic, but it lacks the characteristics of the organic spastic gait in that the soles of the feet are usually dragged or shoved along the floor. Further, there is no involvement of the sphincters and there is an absence of bed-sores and other trophic changes. Sensory disturbances also are commonly present, such as the stocking-like anesthesia already referred to. Finally, if the patient be lying in bed upon his back and he be asked to make an effort to raise, for instance, the right leg, the operator having placed his hand under the left leg, it is found that, as the patient makes an effort to raise the right leg, he *depresses the left leg* on the bed or *vice versa* when the attempt is made to raise the left leg. In other words, the paralyzed limbs are really moved by the patient, though in a manner of which the patient himself is not aware.

The contractures met with in hysteria only rarely simulate the contractures due to organic disease. This is particularly true of the secondary contractures of organic hemiplegia. In hysteric paralysis of an arm, for instance, the arm may in addition be contracted. The position adopted may be that of simple flexion, or some bizarre position may be assumed. This may also be observed in a leg, though here usually the tendency is to rigidity with extension. In the contractures of organic disease it is the distal portions of the limbs, *e.g.*, the hands and fingers, which suffer most. In the contractures of hysteria the limb usually suffers as a whole. Of course, the discovery of associated symptoms, such as anesthesia, or of

other sensory stigmata, such as painful areas, usually determines the diagnosis.

Tremor is every now and then observed in hysteria and may consist of to-and-fro oscillations of variable rapidity. The rate may vary from 4 to 12 in a second. Usually the rate is from 7 to 9 in a second. Quite commonly, too, tremor ceases when the patient is from under observation. It reappears, if absent, or becomes more marked, if present, when the patient finds himself under observation; the extent of the movements also increases. This is likewise true of the tremor when the patient makes a voluntary effort. Finally, the tremor resembles neither the tremor of paralysis agitans nor the coarse movements of multiple cerebrosplinal sclerosis.

Inco-ordination of movement is less frequently met with in hysteria than either palsy, contracture, or tremor. However, when present, it may give rise to an awkwardness in the use of the affected extremity, such as an arm, and is then commonly associated with weakness, *i.e.*, with an hysterical palsy. The presence of anesthesia at once confirms the diagnosis. It may involve all of the extremities. Much more frequently, however, it involves the legs, and we then have present the picture of an hysterical ataxia or a so-called astasia-abasia. Inco-ordination usually becomes evident only when the patient attempts to make an effort; for instance, when he attempts to stand or to walk. When the patient is lying down or sitting in a chair, there is power to move the legs normally in all directions, but when the patient attempts to rise, the ataxia at once

becomes manifest, and if he tries to walk, it quite commonly becomes very pronounced. Hysterical ataxia, of course, is present in varying degrees. Not infrequently, however, it is quite marked. If the patient be able to walk, the gait does not resemble that of locomotor ataxia in the slightest degree. There is great irregularity of gait; wide, oscillatory, coarse, or grossly bizarre movements of the legs, arms, and trunk; quite commonly these phenomena are associated with a demeanor and conduct on the part of the patient as though he were afraid of falling.

**Disorders of the Special Senses.**—When we turn our attention to the special senses, we find phenomena similar to those already considered. The most familiar instance is that in which the visual field is concentrically diminished, *i.e.*, the peripheral portion of the retina appears to be the seat of anesthesia. Every now and then the anesthesia involves the entire retina and then gives rise to hysterical blindness. Very rarely the anesthesia may be irregularly distributed and may simulate a hemianopsia. Contraction of the visual field is suggested to a hysterical patient with the greatest ease; everything depends upon the manner in which the examination is made. The test-object should invariably be carried from the center outward and the fact of failure to perceive it determined by indirect questions.

Quite commonly, it should be added, a contracted visual field is found on the side in which a hemianesthesia is found. At times, too, the limitation of the visual field assumes a character which at once demonstrates its psychic origin, *i.e.*,

the area of the contracted field remains of the same size whether the perimeter is held near or far from the patient, *i.e.*, a so-called tubular vision is observed. Such a modification of vision is obviously psychic. Another remarkable symptom is not infrequently noted in relation to the hysteric retinal anesthesia, and that is the so-called reversal of the color fields. In health the retina is not equally sensitive to the various colors in all portions; thus, violet is perceived in a relatively small central area, green in a somewhat larger area, red in a still larger area, yellow in a still larger, and blue in a still larger area. In hysteria the area in which blue is perceived may become contracted, so that it falls within the area in which red is still perceived; that is, instead of the largest field being that of blue perception, it is now that of red perception, blue perception being so far diminished as to fall inside the limits for red. It would appear that the sensitiveness of the retina to violet diminishes or disappears first, then to green, then to blue, the red persisting until the last. The loss of the color sense is part and parcel of the reduction of the visual field as a whole, *i.e.*, is a phenomenon of anesthesia and is likewise psychic in origin.

Similarly hysteric losses are met with referable to the ear. Hysteric deafness may follow trauma of the ear, may follow suggestion, and may be an accompaniment of a hemianesthesia. Quite frequently its unreal character can be demonstrated by means of a binaural stethoscope; the ends of the tubes being introduced into the ears of the patient, the operator stands back of the patient and

converses with the latter by speaking into the stethoscope in a low voice. The sounds are, of course, conveyed to both ears and the patient naturally replies to questions asked or complies with various instructions. If, now, the physician suddenly compresses the tube leading to the sound ear and the patient continues to hear, he must, of course, hear with the hysterically deaf ear. Usually hysteric deafness, like the loss of vision, is incomplete. Bone conduction is, of course, well preserved, though its existence may be denied and may not be demonstrated save by stealth. It is a remarkable fact also that hysteric deafness is quite commonly, if not indeed always, accompanied by anesthesia of the auricle, of the auditory meatus, and of the drum.

The senses of smell and taste may likewise be involved in hysteria. A patient who has a hemianesthesia may stoutly maintain that he is unable to smell upon the hysteric side or to taste upon this side. Sometimes such a loss of smell and taste are complained of by a patient who does not present the symptoms of a hemianesthesia. Such a patient when tested with various sapid substances will maintain that he does not taste them upon the affected side. If irritating substances, such as capsicum, or if physical irritation, such as pricks with a pin, be now applied to the tongue, the patient likewise denies that he perceives them. In other words, he confuses tactile loss with gustatory loss. Quite commonly we find anesthesia of the tongue, gums, mucous membrane of the cheeks, and lips on the side on which loss of taste is claimed. Similar remarks apply to the loss of the sense of smell. It also

is associated in the patient's mind with tactile loss, and no distinctions are made by him between loss of smell and loss of those sensations which convey physical or mechanical impressions.

**Visceral Symptoms.**—The visceral symptoms of hysteria are, like those already considered, of such a character as to demonstrate their psychic origin. Among these disturbances we have to note especially vomiting, anorexia nervosa, tachycardia, various vasomotor phenomena, rapid breathing, coughing, yawning, retention of urine, variations in the quantities of urine, phantom tumor, aphonia, spurious aphasia, and sexual phenomena.

Anorexia nervosa has already been fully considered in Volume II, page 1, of this Cyclopaedia. Suffice it to say that there is in this condition a more or less marked loss, sometimes a complete loss, of the desire for food. That this loss of the desire for food may be accompanied by loss of weight and may offer profound difficulties in the way of treatment, but that it may be overcome by suggestion and by forced feeding, has already been pointed out in the article above referred to.

Hysteric vomiting when present may be associated with anorexia nervosa and may be so profound as to simulate vomiting the result of organic disease. Pain may be referred to the epigastrium and may lead to the erroneous diagnosis of gastralgia. It may, further, be exceedingly limited in character and distribution and thus may simulate gastric ulcer. The patient may even spit blood and in this way simulate the bleeding of such an ulcer. However, the differentiation is, as a rule, made without

practical difficulties. There is really an entire absence of all genuine evidence pointing to organic disease, such, for instance, as is furnished by test-breakfasts or by a microscopic examination of the stomach contents. At most there may be some atony of the stomach or possibly a mild secondary gastric catarrh, but usually there is nothing.

Tachycardia is often observed as a complication of hysteria. This tachycardia may be, and frequently is, associated with localized flushings of the face, trunk, or extremities. Sometimes pallor and coldness of the surface of the body and the extremities may be noted. Hysteric rapid breathing is also occasionally observed. The increase in the rate of respiration may be very great; as many as 90 respiratory acts to the minute have been counted. It is not necessarily accompanied by tachycardia. Indeed, most frequently there is no disturbance of the pulse rate nor is there any dyspnea or any evidence of cyanosis. It need hardly be added that neither is there any evidence of any cardiac or pulmonary lesion.

Hysteric cough is a not infrequent symptom. As a rule, this cough is dry and is unaccompanied by any physical signs. Sometimes, instead of cough, curious cries or sounds are emitted, which suggest the barking of a dog, crowing of a cock, or other bizarre sounds. In other cases again frequent and excessive yawning may be observed. As a rule, the act of yawning is very greatly exaggerated and very prolonged. Hysteric sneezing should also be added to this category.

At times the patient loses his voice;



at other times he is mute, being apparently unable to speak. In both of these conditions, hysteric aphonia and hysteric mutism or aphasia, the signs themselves are of such a character and the other phenomena present usually so pronounced and unmistakable as to leave no doubt as to the nature of the symptoms.

#### **Miscellaneous Somatic Symptoms.**

—Among other symptoms, fever has been described as occurring in hysteria. Déjerine was one of the few modern writers who still believed in its existence; the author, however, after an experience of thirty years in the hospitals without observing a single instance, is compelled to deny its existence. Fraudulent tricks with the clinical thermometer he has met with, true fever never. Trophic disturbances have also been claimed. These, likewise, the author has never observed. So-called hysteric ulcers and other skin lesions disappear as soon as the patient's access to them is prevented by a plaster-of-Paris bandage or similar mechanical device. Now and then the muscles of a limb which has been persistently hysterically paralyzed for a long time show some diminution in size. This diminution is, however, never very marked, and results simply from disuse and cannot in any sense be termed trophic.

The localized swellings and edemas which are at times noted as occurring in connection with paralyzed limbs—never very marked—are likewise to be attributed to disuse and secondary circulatory disturbances. Local flushings, dermatographia, and kindred phenomena are but part and parcel of the other circulatory changes admittedly the result of psychic and

emotional influences. Blushing, pallor, and other vasomotor perturbations can hardly be termed trophic.

The sphincters are now and then disturbed in hysteria, though such disturbance differs radically from that met with in organic disease. Very often the patient presents the symptom of unusual frequency of micturition. Less often he asserts that he cannot hold his water; however, if the clothing and bedding of such a patient be examined, it presents no evidence of having been soiled or stained nor is there any odor of urine. Willful deception may, of course, be practised. Now and then retention of urine is complained of, but it is a retention which is often not true and when neglected leads to no evil results. True paralysis of the bladder or sphincter, it need not be added, is never observed.

Many hysteric patients present the symptom of polyuria; such patients, as is well known, may pass a very large amount of urine, especially after an hysteric paroxysm or hysteric emotional disturbance. The urine in such cases is light colored and of low specific gravity. Less frequently cases of hysteria are met with in which the urine is greatly diminished in amount and in given instances the claim of an absolute anuria is made. That such claims are fraudulent goes without saying. Patients with hysteric anuria never, of course, present the grave symptoms associated with the actual suppression of urine; indeed, symptoms of suppression are conspicuous by their absence. Further, when such patients are observed by stealth, it is found that, although the night vessel is not used, it may be that a soap dish or pitcher or other

article about the room has been utilized and the urine subsequently surreptitiously disposed of when the patient believes herself from under observation. Such conduct on the part of the patient is in keeping, as we shall see, with other psychic phenomena not infrequently present.

Now and then we may observe an undue distention of the abdomen, so that the patient may present a superficial appearance of pregnancy. At times also, due to an irregular contraction of the abdominal muscles, the distention is irregular in outline and in this way a so-called phantom tumor may be produced. The physical examination, of course, reveals the nature of such phenomena. Now and then phantom tumors are due to a local contraction of a muscle; for example, to a contraction of a belly of the rectus.

A large number of cases of hysteria, more especially cases of traumatic hysteria, complain of sexual disturbances. Not infrequently men claim that they have become impotent. Women, as we have already seen, may complain of their inability to receive their husbands because coition is attended by suffering. Such cases, we should remember, are cases of vaginismus dependent upon superficial painful areas in the vagina. That there is a great field here for gross misstatement and willful deception need not be pointed out. Besides it is usually impossible either to verify or to disprove the assertions of the plaintiff. However, it has occurred in more than one occasion in the writer's experience that during the long delays pending trial, a woman making such a claim has become pregnant and given birth to a

child, thus proving the falsity of the claim. Similarly, in the case of men claiming to be impotent, their wives have borne children; for example, in the case of a man suffering from hysterical hemiplegia there were two trials. In the first the claim of entire loss of sexual power was made. For some technical reason a second trial was granted; the second trial was not reached for another year. In the mean time the wife gave birth to a child, the paternity of which at the second trial the plaintiff admitted. In another instance in which settlement was made largely on the basis of the impotence claimed, the wife gave birth to twins within the year.

**Psychic Symptoms.**—The symptoms of hysteria thus far considered bear the unmistakable impress, as has been insisted upon throughout this article, of a mental origin. The mental condition of the patient also has to some extent been discussed. It is necessary now, however, to consider in detail some of the psychic symptoms themselves.

The mental symptoms, like the motor, sensory, and visceral symptoms, impress us with their unreality and unessential character. In fact, there is something about them which even to the lay mind suggests their real nature. The simulation of abnormal mental phenomena is grossly imperfect. States of emotional excitement are very common, but the shrieks, screams, wild cries, and weeping deceive no one. At most a delirium or mental confusion may be simulated, but here, as in the case of the physical signs, the symptoms have the appearance of something that is not genuine, something assumed, something voluntarily and

artificially produced. This is usually quite obvious in the ordinary hysteric paroxysm. Hysteric attacks may vary greatly in intensity, as well as in the symptoms which they present. They may be limited to comparatively slight emotional disturbances attended by weeping and laughter, or by transient changes of speech and conduct in which the emotional factors are so evident that even the laity recognize the attacks as hysteric. Instead of being slight, the attack may be pronounced and even prolonged. Usually such an attack is preceded by a prodromal period extending over a number of minutes, several hours, or it may be over a day or two. During this period the patient frequently becomes depressed, avoids the members of her household, is uncommunicative, irritable, and perhaps is angry or weeps upon slight provocation. Less frequently the patient is excited, restless, perhaps a little exuberant or even boisterous, or she may laugh and weep by turns. Less frequently still, she acts as though she had frightening visions, sees strange faces and objects. Very commonly she complains of choking sensations, clutches at her throat, says that she cannot breathe, has headache or other distressing feelings. Rarely a picture suggesting a frank delirium is observed. Sooner or later a convulsion sets in. This convulsion is attended by a tonic spasm, during which the patient may present rigidity of all of the muscles of the limbs and trunk; at times, indeed, an opisthotonus, an "arc de cercle," may be present. Soon, however, the tonic spasm is followed by clonic movements, which are much greater in extent than those seen in epilepsy and of themselves usually

suggest a voluntary character. Hysteric attacks are of variable duration; some are brief, others more prolonged, and in the latter the patient may contort the body into various bizarre positions, or may make gestures and movements clearly expressive of volition and purpose. Sometimes the patient tears her clothing, dishevels her person, assumes dramatic and passionate attitudes, shrieks and weeps. Little by little she becomes quiet, submits to the ministrations of her friends, and conducts herself normally, or, perhaps, goes to sleep.

It is characteristic of the hysteric attack that during its continuance the patient does not lose consciousness, a fact that is rarely admitted by the patient, but commonly capable of convincing proof; sometimes the fact that the patient is conscious during the attack is self-evident. The patient never hurts herself and betrays by her actions or by her subsequent statements a knowledge of her environment. The sphincter control is never lost, nor is there ever any biting of the tongue, as in epilepsy.

Instead of subsiding, the attack may pass into a phase in which the patient seems to hear voices, to see visions, and in which she utters disconnected phrases, is exalted, depressed, erotic, obscene. At other times, the patient appears to pass into a condition resembling somnambulism. Contrasted with delirium due to an infection or an intoxication, a crass difference becomes apparent. The visions which the patient sees and which she dramatically addresses, give the bystander the impression of being assumed, not genuine. The illusions of persons and objects are often exhibited in such a way as to

give rise to the same conviction. The patient, being told that a certain person is her father, dramatically calls him by a strange name, and yet a moment later betrays that she knows exactly who the designated person is. Finally, neither the incoherence nor the delusions recall those of delirium proper. Long sentences and long phrases, at all times with a rich emotional content, replace the unrelated fragments uttered in the genuine affection. It must be admitted, however, that at times, though rarely, the hysteric delirium simulates the delirium due to other causes more closely. The patient not only sees objects from which she shrinks or toward which she makes movements of defense, but she also hears voices, to which she makes response.

The duration of a hysteric attack may be quite short, sometimes a few minutes, sometimes a few hours, rarely a day or more. Sometimes, instead of the patient becoming quiet and conducting herself in a normal manner, a confusion persisting over a number of hours may make its appearance. This confusion is sometimes exceedingly mild in character. At other times it is more pronounced and is to be looked upon as a continuation of the hysteric attack itself.

Instead of resuming a normal behavior at the end of an attack or of simply dropping off into a natural sleep, the patient may pass into a sleep which is very profound, from which it may be impossible for the time being to rouse her and which is sometimes spoken of as hysteric stupor or coma.

Sometimes a hysteric paroxysm manifests itself by a sudden onset of confusion without a preliminary con-

vulsive period. Sometimes, too, sleep or stupor may suddenly supervene in a similar manner, a condition termed hysteric narcolepsy. Such a sleep is variable in duration, extending over a fraction of an hour, a number of hours, or it may be over several days. Instead of being profound, it may manifest itself merely as a kind of lethargy.

Sometimes ecstasy or cataleptic phenomena are observed during a paroxysm; at other times, still, a somnambulism makes its appearance, the patient's conduct simulating the somnambulism of hypnotism. Occasionally such a somnambulism comes on spontaneously. In this state the patient may perform various acts, often complex in their nature, requiring considerable time and bearing no relation to the occasion or to the environment and during the performance of which the patient is entirely oblivious (?) of her surroundings. Such attacks usually terminate quite suddenly, the patient subsequently having no recollection (?) of what has occurred. Such symptoms can only be accounted for on the basis of a psychic dissociation. One group of ideas, as in the somnambulism of hypnosis, occupies the field of consciousness to the complete exclusion of all others; that is, there is a separation of the personality into two parts which have no relation with each other. Such a cleavage of the personality may be quite persistent, so that the patient, for long periods of time, acts exclusively under the influence of one group of ideas and associations, and subsequently acts under another group and conducts himself as though he were possessed of two personalities. While in one

state it would appear that he has no knowledge or recollection (?) of his experience while in the other. Such instances of dissociation are remarkable, but, after all, no more remarkable than the cutting out of an entire limb or one-half of the body from consciousness, such as occurs in the case of an hysteric palsy or hysteric hemianesthesia. One morning a young physician left his office to go to a hospital, with the outdoor service of which he was connected. He did not appear at the clinic nor was anything heard of him for two days. He suddenly came to himself on a country road, many miles from his home. He had no idea of where he was, or how he had gotten to the place at which he found himself. He had evidently purchased a ticket, boarded a train, gone to a hotel, paid for food and lodging; he had also apparently lost his straw hat, for, when he came to himself, he was wearing a cap; the latter was new, and it may be properly inferred that he had purchased it. Evidently he had committed no act which had been unusual, and nothing in his demeanor had attracted attention. The case of Ansell Bourne, reported by William James, is even more interesting, because the change to the abnormal personality was of longer duration and more complete. The patient was an itinerant preacher, who disappeared one morning from his home in Providence and reappeared two months later in Norristown, where, under a new name, he had conducted a small stationery store. He came to himself suddenly in a fright, and asked to know where he was. The case studied by Morton Prince, and the story of which is related by the

patient herself, reveals a still more remarkable instance of a dissociated or disintegrated personality. Regarding all such cases, however, a legitimate doubt of their genuineness may be entertained. Hysteric people often like to be interesting and enjoy occupying the center of the stage. That they practise gross deceptions in order to secure the sympathy and attention which they crave, every hospital physician knows. That they will simulate anuria, rise of temperature, or what not, that they will undergo severe procedures, face painful operations, in order to achieve this end, is a matter of common knowledge. That they may lie concerning so interesting a phenomenon as double personality is extremely probable. Further, human motive is sometimes very obscure, and the reason may not always be apparent why a man should conduct himself in a manner suggesting that there is a motive for concealing himself or, possibly, for making an entirely new start in life under entirely new conditions. Unfortunately, too, it is not always possible to separate truth from falsehood, and in no case is this more difficult than in hysteria.

In some cases of hysteria a serious and persistent pathologic attitude of mind may supervene. As already pointed out, visceral symptoms are not infrequent, and these may lead the patient to believe that she is seriously ill, that this or that portion of her body is seriously affected. Under these circumstances she develops an inordinate desire for sympathy and constantly demands medical attention. She recites her symptoms with a degree of minuteness that is painful and repeats the account with

much evident satisfaction, retails with endless elaboration her experiences with various physicians and various cures. Indeed, such a patient is not quite happy unless she is under the care of a physician or a surgeon. Sometimes the list of operations that such a patient has passed through is appalling, and may include in one and the same case removal of the appendix, of the ovaries, of the uterus, excision of the coccyx, sewing fast one or both kidneys. Such patients are among the most difficult with which a physician has to deal.

**DIAGNOSIS.**—The diagnosis of hysteria is to be based upon the cardinal feature of the psychic character of the symptoms. The sensory phenomena, the anesthetics, and more especially the painful sensory stigmata can be recognized with ease. The same is true of the motor phenomena and almost equally true of the visceral symptoms. The psychic symptoms are also easy of recognition. This is true alike of the paroxysm and of the interparoxysmal mental state. The hysteric fit is to be differentiated from epilepsy, for instance, by the fact that in epilepsy consciousness is invariably lost; in hysteria consciousness is never truly absent, though it may be perverted or possibly obscured for the time being. Again, in the hysteric seizure tonic contractions and rigidity predominate, not clonic movements, as in epilepsy. Further, the hysteric patient never bites his tongue, as does the epileptic, nor is there ever any loss of control over the sphincters, a very common occurrence in epilepsy. In the interparoxysmal period we have, first, the extreme susceptibility to suggestion, which manifests itself

by the ready acceptance of symptoms of all kinds and, secondly, a marked emotional instability. While it is easy to establish the presence of hysteria in a patient, the fact should not be forgotten that hysteria every now and then complicates actual organic disease. Further, the picture may be sometimes exceedingly involved when hysteria complicates another functional neurosis, such as neurasthenia, which it not infrequently does. In such an instance the patient presents the fatigue neurosis, to which the symptoms of hysteria have been added. Similarly, hysteria may complicate a true epilepsy, but such an occurrence is very infrequent.

**PROGNOSIS.**—The prognosis of hysteria is always favorable as regards the attack from which the patient is suffering. In the large majority of patients, suggestion is wonderfully efficacious in bringing about the disappearance of the symptoms. It is this fact which has led Babinski to invent a new name for hysteria, namely, "pithiatism," *πειθαιν*, "to persuade"; *ιατός*, "curable," which means, literally, curable by persuasion. Quite frequently it happens that symptoms persist until certain causes which have to do with this persistence disappear. Notably is this the case with the hysteria of litigation. The courts are constantly filled with claimants who present the symptoms of hysteria, the latter having had their origin, according to the claim, in trauma, the claimant then being said to suffer from so-called traumatic hysteria. In such cases a palsy, a tremor, inco-ordination, or other symptom may follow a fright or a trivial blow upon some one portion of the trunk, head, or limbs; indeed,

pronounced hysteria may develop under these circumstances. Such a hysteria undergoes no change, even when the most radical efforts at cure are made. The symptoms persist indefinitely—if anything, steadily become more marked—until the case is settled, the money actually paid over, or the case otherwise legally disposed of. Very frequently, a hysteria which would rapidly subside if litigation ceased persists for months or even years. The fact that an injury resulting from a railway or other accident involves legal liability necessitates a closer questioning and more careful taking of records on the part of the physician, not only at his first, but also at his subsequent, visits, than is the case with ordinary patients. In due course again the claimant rehearses his symptoms in consultations with his lawyers, and many times repeats this rehearsal during the subsequent examinations by the medical experts. The patient is thus subjected to a kind of training, to a process which fixes the symptoms firmly in his mind; indeed, the symptoms always become more pronounced during the preparations for trial.

The methods pursued are pernicious in the extreme and utterly subversive of justice. It is noteworthy that if trial be not reached, or be for some reason postponed, the symptoms become less marked, and indeed often largely subside until the next date of trial approaches, when they again become more pronounced and often worse than before; indeed, new symptoms sometimes now make their appearance. These facts owe their existence to the renewed and repeated medical examinations and to

the rehearsals in the consultations with lawyers.

The true relation which the hysteria in such cases bears to the accident is shown by the history of these patients when their cases have been settled and litigation disposed of. Time and again experts testify upon the stand that a prolonged course of rest treatment is necessary to restore the patient to health, and yet the experience of the writer, extending over a quarter of a century and embracing many hundreds, if not thousands, of cases, fails to reveal a single instance in which, subsequent to the settlement of a case, the plaintiff submitted himself to a rest treatment. In other words, the plaintiff recovers when the element of litigation has been removed. All treatment ceases with the settlement; the symptoms disappear and the patient forgets all about them. It must be accepted as an established fact that the plaintiff neither gets well nor improves, no matter what treatment is adopted, so long as his claim remains unsettled or so long as there is any hope of settlement.

**TREATMENT.**—The first step in the treatment of a case of hysteria is the recognition by the physician of the fact of hysteria and the exercise of great care by him in studying the symptoms. The history of the illness should, as far as possible, be elicited from the friends and relatives of the patient and never in the patient's presence. Secondly, the study of the various physical stigmata should be made indirectly and every precaution should be exercised, if such symptoms are patently present, not to accentuate these in the patient's mind. The diagnosis can almost invariably

be easily established without making either prolonged or elaborate observations. Studies in which an anesthetic area is carefully mapped out or in which the exact limitations of a visual field are developed during a prolonged examination have, it is needless to say, a most injurious effect upon the patient. Equal care and reserve should be exercised in the studies of the various painful hyperesthesias. It is unnecessary to press hard or to press repeatedly over a given painful area and still less necessary is it to delimit its exact extent. Such a procedure is justifiable only when the significance or the character of the pain is doubtful or when there is really reason to suspect an underlying visceral disease. As a rule, visceral disease is readily excluded and the fact that the examination results negatively in this respect is frequently a great relief to the patient's mind.

Especially should the physician be careful to see to it that his examination is made in such a way as not to suggest the appearance of new symptoms; otherwise, great harm may be done. If the physician exercises due care in the manner in which his examination is made, his examination may give rise indirectly to suggestions which, instead of being harmful, are very beneficial to the patient. Such suggestions need not necessarily be made in words. Patients frequently present themselves to physicians with their special symptoms already well developed. The physician may tactfully recognize and admit frankly the special symptoms of which the patient complains, but he may reveal by his manner and by his general attitude in the examina-

tion that he does not consider these symptoms as serious or he may remark that he has often met with similar symptoms and has always seen them under proper treatment disappear. Now and then it happens that a hysteric patient is jealous of her symptoms, is anxious that the physician shall be duly impressed not only with their existence, but with their severity. Under such circumstances it is, of course, a mistake to minimize the symptoms unduly, at least at the first interview. If so, the patient may come to the conclusion that the physician does not understand her case, that he does not appreciate her condition, and that he has no sympathy for her, no feeling for her, and thus she may never give him a full share of her confidence. The proper examination of a hysteric person requires infinite tact, as much, if not more so than does the subsequent treatment. Every hysteric patient is anxious to detail her symptoms fully to the physician and, although the latter may already have received a full account from the relatives, it is important that he should appear to be both interested and sympathetic. My experience has convinced me that in cases of hysteria everything depends upon making a success of the first interview with the patient and during this interview the patient must be allowed to talk freely, long, and uninterruptedly. Little by little, questions of a general character can finally be ventured and gradually the patient can be led up to the point of the medical examination. It is important that this should be conducted, at first, not from the standpoint of the neurologist, but from that of internal medicine, and, the physi-



cian finding that nothing is revealed by his examination of the heart, of the lungs, of the abdominal viscera, or of the digestive tract, and dismissing each organ in turn, the patient is very apt to receive the suggestion that there is really nothing very serious the matter with her. Finally, if a good internal medical examination be made, organic disease, if really present, is revealed. If hysteric stigmata be present, they can readily be discovered during this visceral examination and by methods which do not impress their existence upon the patient.

If possible, the physician should get into close touch with his patient, for unless the patient gives him her confidence all of his efforts may fail. Except in the rare instances in which the opposite course shall be deliberately determined upon for special reasons, the suggestions of the physician as to the unimportant character of the nervous symptoms and as to their early disappearance should not be made bluntly or too emphatically. As far as possible the suggestion should be made indirectly and should, of course, be repeated at subsequent visits. The suggestions can, of course, be made in numerous ways, by word, by action, by silence, by relative inattention. After a time it is often expedient to ignore the existence of this or that symptom altogether. This is especially true of the sensory stigmata, and when one group of them begins to fade, as a rule all begin to fade. If a suggestion be made too directly, too openly, or too frequently, it may constantly keep the symptom before the patient's mind and thus, instead of aiding the physician to bring about a

cure, defeat his object. The appearance of indifference as to a symptom or set of symptoms must, of course, be avoided, and the exact course applicable to a given case must depend upon the individual judgment, good sense, and tact of the physician. Of one thing, however, he should make certain, and that is that every visit that he makes to his patient leaves her with the impression that she is getting better and that she will inevitably get well. The treatment of hysteria is essentially a treatment by **psychotherapy**, but as Déjerine found it advisable again to point out, psychotherapy will fail unless the patient has confidence in and likes her physician. In relatively mild cases of hysteria, *e.g.*, office patients, such a system of psychotherapy may be all that is required. Quite commonly, too, it serves the purpose even in cases which the physician finds in bed. Every now and then, however, especially if the hysteria be marked, it is necessary to institute isolation,—isolation from friends and relatives, separation from a too anxious mother or daughter, from one who is constantly questioning the patient with regard to her symptoms and thus keeping the memory of them alive or who by the constant demonstration of her sympathy keeps the emotions of the patient, already unstable, in a condition of constant upheaval.

Quite frequently it is a good plan to institute a **rest treatment** such as proves so efficacious in the treatment of neurasthenia. Under such circumstances the patient is best treated away from home, in a private room, in either a public or a private hospital. The private hospital is, other things equal, to be preferred, because

of the more complete and effective isolation that can be instituted. Complete isolation is in many cases imperative and in given instances all communications with friends and relatives, whether by letter or indirectly by cards, flowers, or gifts, should be interdicted. No matter with what precautions such communications to a hysteric patient are surrounded, they inevitably do harm. Especially is this the case in the early part of the treatment. Later, when convalescence has been firmly established, flowers and books and the like may, according to judgment, be permitted.

If isolation be determined upon, a trained nurse becomes, of course, a matter of necessity. The nurse for the successful management of a case of hysteria must be possessed of certain important qualities. No matter how well she is trained, the physician should always explain to her beforehand the nature of the case and to some extent enter into the details of the symptoms which are present. The nurse should be instructed at first to play a passive rôle as regards the symptoms, to admit to the patient, if necessary, their reality and to observe them carefully. Under no circumstances should she, save under the instruction of the physician, attempt to suppress or to dispute the symptoms. Argument and vigorous methods are usually disastrous and otherwise objectionable. If the nurse at first minimizes the symptoms or what is still worse denies their existence, she never secures a hold upon her patient and her presence then in the sick-room does more harm than good. The nurse should endeavor by her conversation and demeanor to

keep up gently, day by day, the impression that the patient is getting well. However, she should avoid the rôle of a too sympathetic and pitying or too affectionate friend. How disastrous such a course is, need hardly be pointed out. Her attitude should be that of a calm, quiet, and cheerful companion whose business it is to carry out faithfully and without modification the instructions of the physician. Much depends upon the nurse; if deficient in tact, she is useless. The qualities which make a nurse successful in hysteria are usually inborn. Many nurses are utterly incapable of acquiring them. Some patients, for instance, need a little sympathy; they cannot get along without it; they will not improve without it. In other cases again the slightest exhibition of sympathy destroys the control of the nurse over the patient. It is best at first for the nurse to adopt an intermediate course, at least until she has gotten well acquainted with her patient.

In addition to suggestion, isolation, and the employment of a properly trained nurse, we should institute rest measures comparable to those used in neurasthenia. Quite frequently, because of the unphysiologic existence which she has led, the patient has suffered somewhat in general health and, in addition, therefore, to **rest in bed**, we should employ **liberal feeding** and supply the need of **exercise by massage and by electricity**; careful though not excessive use should also be made of **bathing**. **Physical exercise**, the character of which has been carefully determined, —especially when there are present motor stigmata,—is also under given conditions important.

In the majority of cases of hysteria in which the affection is so pronounced as to demand rest in bed, the rest should be absolute. As a rule, it is wise, as in neurasthenia, to permit the patient to leave the bed only to empty the bowels or to void the urine. As in neurasthenia, the **diet** should be simple and should contain comparatively small amounts of the carbohydrates, and but a moderate amount of the red meats. The white meats and succulent vegetables should be taken freely. Milk is also an important factor and should be given in increasing quantities, especially if the patient is below weight. Raw eggs may also be utilized just as in the ordinary rest treatment of neurasthenia. Special conditions may demand special modifications of the diet, as in anorexia nervosa and in hysteric vomiting, and how this can be combated was shown in the article on Anorexia Nervosa, in Vol. II, p. 7.

The **massage** should be given daily. We should bear in mind, however, that this procedure, which is so often calmate and soothing in neurasthenia, is often distasteful and irritating to hysteric patients, especially when areas of painful hyperesthesia are present. The massage should at first be gentle, later on vigorous, and should gradually be made deep and directed to the muscles. Areas of painful hyperesthesia should be carefully avoided at first, but little by little these areas should be encroached upon; before the patient is fully aware of it, they should be fully included in the rubbing. Many days may pass before this can be accomplished, but little by little such painful areas disappear and are literally rubbed out.

The **bathing** had best be very simple in character. Tub bathing or other forms of vigorous bathing should at first be avoided. A simple warm sponge bath between blankets, just as in the rest treatment of neurasthenia, answers every purpose. Later on, according to circumstances, douching, spraying, or the drip sheet should be employed.

**Electricity** may also be employed. The **slowly interrupted faradic current** may be used to stimulate the flexor and extensor muscles of the limbs and the muscles of the trunk; it is an adjuvant to the massage. Now and then the **rapidly interrupted faradic current** is used as a local stimulant and is often very efficacious in dispersing painful areas. The **constant galvanic current** can also be used for this purpose, the anode being applied over the painful area. If other forms of electric treatment are available, they may occasionally be employed with advantage. Among these are **static electricity**, the **sinusoidal current**, and **high frequency**. These methods can hardly ever be said to be necessary; they are to be looked upon as adjuvants in the way of suggestion.

The various visceral symptoms that may be present in a given case must be treated by appropriate methods, in which **suggestion** plays the leading rôle. Similarly anesthetics and palsies disappear rapidly under skillful suggestion, and this is also true of contractures. Pain, insomnia, and other symptoms, such as retention of urine, as a rule, yield rapidly to the administration of **placebos**. I know of no more powerful hypnotic in the insomnia of hysteria than a capsule of 5 grains (0.3 Gm.) of starch when

administered with a properly made suggestion.

The therapeutics of hysteria is, even when the patient cannot be adequately isolated, not a difficult problem. Quite commonly the success achieved is great and achieved without undue delay. In the experience of the writer, it is not necessary to resort to psychoanalysis. The latter, if it be of use at all, is of special use only in the psychasthenias, in the neurasthenic-neuropathic insanities in which the leading rôle is played by phobias and obsessions. Further, it is questionable whether in the case of a neurosis, such as hysteria, in which the affection is inborn and is part and parcel of the makeup of the individual, it is wise to question him with regard to the intimate personal facts of his sexual life. There is grave danger of suggesting new symptoms and of inextricably complicating the case. It is further questionable whether such a procedure is justifi-

able ethically, unless there be factors in the case which suggest that the symptoms are directly sexual in origin. Suffice it to say that simple psychotherapeutic measures, especially indirect suggestion coupled with simple physiologic procedures, yield results very promptly.

After the symptoms present in a given case have been brought under control or their disappearance brought about, the patient should be taken in hand and, whenever practicable, mentally retrained. To achieve this object, nothing is so valuable as an **occupation**, one that will actively interest the patient and develop and strengthen her best qualities both mentally and physically. Or, in other words, nothing will produce greater emotional stability than a wholesome occupation which fills the day with normal thoughts and feelings.

F. X. DERCUM,  
Philadelphia.

# I

**ICHTHYOL.**—Ichthyol (ammonium ichthyol-sulphonate) is a distillation product prepared from a bituminous mineral found in the Tyrol which is rich in fossilized remains of fish and sea-animals, whence the name "ichthyol" (*ἰχθυός*, fish). By dry distillation of this bituminous mineral a crude volatile oil is obtained which, at temperature of 212° F., is treated with an excess of concentrated sulphuric acid, forming ichthyol-sulphonic acid. This latter substance unites with the alkaline bases (ammonium, sodium, lithium, etc.) and forms ichthyol salts, of which the principal ones are ammonium ichthyol-sulphonate (or ichthyol-ammonium) and sodium ichthyol-sulphonate (or ichthyol-sodium), the former being always understood when the term ichthyol is

used alone. These substances are rich in sulphur (about 15 per cent.), which is combined partly with oxygen, partly with carbon, in a condition similar to that existing in mercaptans and organic sulphides (Baumann).

Ichthyol, when pure, has a reddish-brown color and a bituminous taste and odor. The sodium salt is semisolid (of the consistency of a solid extract), and the ammonium salt is a thick, brown liquid of the consistency of syrup. Ichthyol should be completely soluble in water, and is almost entirely soluble in a mixture of equal parts of alcohol and ether. It is only partially soluble in alcohol or ether alone. It mixes well with lanolin, petrolatum, glycerin, fats, and oils, and with collodion and traumaticin.

**PREPARATIONS AND DOSE.**—Ichthyol is not official. The following preparations are used:—

Ichthyol (ammonium ichthyol), a syrupy liquid with a characteristic empyreumatic and burning taste. Dose, 3 to 30 minims (0.2 to 2 c.c.).

Sodium ichthyol (sodium ichthyol-sulphonate), a dark-brown mass, of more solid consistency than the preceding. Dose, 3 to 30 grains (0.2 to 2 Gm.).

Calcium ichthyol (calcium ichthyol-sulphonate), a brown, tasteless, insoluble powder.

Silver ichthyolate (ichthargan), containing 30 per cent. of silver and 15 per cent. of sulphur in organic combination, and occurring as a brown powder with faint, chocolate-like odor, freely soluble in water, glycerin, and dilute alcohol. Its solution darkens when exposed to light. Used externally in 0.04 to 3 per cent. solution.

Ichthyol albuminate (ichthalbin), a compound of albumin and ichthyol-sulphonic acid, occurring as a fine, grayish-white, odorless, and nearly tasteless powder, soluble only in alkaline liquids. Dose, 10 to 20 grains (0.6 to 1.2 Gm.).

Ichthyol formaldehyde (ichthoform), a compound of ichthyol and formaldehyde, occurring as a dark-brown, nearly odorless and tasteless powder, which is stable and insoluble in the ordinary solvents. Dose, 10 to 30 grains (0.6 to 2 Gm.); also used externally pure or in 10 to 25 per cent. ointment.

**PHYSIOLOGICAL ACTION.**—Ichthyol has antiphlogistic, anodyne, alterative, antipruritic, antiseptic, and astringent properties. Its peculiar virtues are largely ascribed to the large amount of sulphur it contains. According to Rudolf Abel, ichthyol acts more strongly against streptococci and diphtheria bacilli than staphylococci and other organisms. Solutions weaker than 50 per cent. should not be made for prolonged keeping.

When administered internally, although having a peculiar odor, it excites no nausea. In medicinal doses it is believed that it retards the disintegration of protein substances and favors their assimilation (Zuelzer, Charles). In larger doses it increases peristalsis and has a laxative

action. Helmers found that a third of the sulphur contained in the drug is eliminated by the urine, while the remaining elements pass out in the feces. He also found that the sulphur of the ichthyol takes at least seven days to be completely removed from the organism, and hence concluded that ichthyol does not simply pass through with the food, but is first absorbed into the system and then excreted.

When applied locally, it is said to act as a reducing agent (abstracts oxygen from the tissues) and to exert a peculiar constricting effect upon the vascular tissues; hence the application of ichthyol is followed by a diminution of heat, a reduction of swelling, pallor of the tissues, and relief of pain (Unna). Von Nussbaum has proved, moreover, that ichthyol, taken internally, benefits only those asthmatic affections, digestive disturbances, pelvic neuralgias, and sciaticas which are associated with anomalies of circulation and capillary dilatation.

Ichthyol undoubtedly inhibits bacterial development, as proved by the experiments of Fessler and Klein. Injected subcutaneously, it lowers the rectal temperature for about an hour (Dujardin-Beaumetz). When rubbed into the skin it is to some extent absorbed.

**Untoward Action of Ichthyol.**—While ichthyol is proverbially a soothing agent, in very exceptional cases it may exert a severely irritant effect; the explanations of this occasional variation have not been satisfactory.

A patient needed a mercurial ointment for application over an orchitis. To insure non-irritation of the thin, sensitive skin, the author prescribed 25 per cent. ichthyol as a diluent. For the first time in nearly thirty years of his experience the ointment acted as a violent irritant and speedily had to be removed. Heitzmann has known as weak a proportion as 10 per cent., in an ointment otherwise wholly bland, to blister within half an hour. No further explanation than "idiosyncrasy" has been advanced to account for these occasional results. The author suggests that among the immense pre-

ponderance of non-poisonous fish in the material from which ichthyol is derived there may remain a few, here and there, unsafe both for ingestion originally and for local application now. The continued poisons have become even more virulent with time. R. H. M. Dawbarn (N. Y. Med. Jour., Sept. 3, 1910).

**THERAPEUTICS.**—Ichthyol has been credited with many widely different therapeutic properties. While not a panacea, its use as a seemingly valuable aid in treatment has been widespread.

Ichthyol can be used pure, or dissolved in any of the usual solvents. Internally, it can be administered in substance, in pill, capsule, or in watery solution (adding some essential oil to cover the taste). When given in pill form it is advisable to use sulphoichthyolate of sodium, the consistency of the latter better adapting it for this purpose. When it is given in solution, a mixture with an equal volume of water may be used; of this, 1 or 2 drops may be taken three times daily in a little water, the dose being gradually increased every three days by 1 drop, until 10 drops or more are being taken *t. i. d.* (not on an empty stomach). Should gastric pressure or a burning sensation be felt, it is an indication either that the ichthyol has been taken without sufficient dilution or that the maximum dose for the patient is being exceeded; usually the former is the cause. According to Vigier, after some days' use of ichthyol the stomach will tolerate  $\frac{1}{2}$  to  $1\frac{1}{4}$  drams (2 to 5 c.c.) of it.

Externally, ichthyol can be used in a spray, by inhalation, or in a gargle; in ointment, paste, dusting powder, or lotion; in vaginal, uterine, or rectal suppositories; in urethral bougies; on tampons; in watery or oily solutions, or as a varnish (dissolved in collodion or traumaticin). Unna, to produce an impermeable layer of ichthyol which can be easily and quickly removed without irritating the skin, uses the following: Ichthyol, starch, of each, 40 parts; concentrated solution of albumin, 1 to  $1\frac{1}{2}$  parts; water, enough to make 100 parts. The starch must first be moistened with the water, the ichthyol then well rubbed in, and, finally, the albumin added. Ichthyol may also be

used in admixture with lanolin, zinc ointment, or glycerin, in strengths of from 5 to 50 per cent. For a regenerative action, according to Cranstoun Charles, weak ointments are better; for a resolvent action, as in gout, rheumatism, and neuralgias, strong ones are preferable.

When ichthyol is applied externally, previous washing (except when contraindicated, as in eczema) of the afflicted parts with soap and warm water, followed by gentle drying, is advisable. After the painting, inunction, or embrocation, it is best to cover the parts with carded cotton or flannel, and apply over all some rubber cloth or tissue, to prevent evaporation, repeating the process night and morning. To avoid staining the clothes, ichthyol may be applied pure and then dusted with French chalk to form a crust, the usual dressings being afterward applied. The odor of ichthyol may be disguised, if desired, by the addition of a small quantity of vanillin or cumarin, or of the oils of citronella, eucalyptus, or turpentine; the addition of 1 part each of oil of bergamot and oil of eucalyptus to 50 parts of ichthyol has also been recommended.

The remedy can be administered by subcutaneous injection in weak, watery solutions (1 to 3 per cent.), but if not freshly prepared the solution must be previously sterilized by boiling for a short time before using. For the hypodermic injection of exudates and tumors, solutions as strong as 50 per cent. have been employed. Injection of ichthyol is, however, no longer frequently resorted to.

The stains upon the clothing and bed-linen soiled during the application of ichthyol may be removed by boiling in soap and water, or by washing with soft soap or soap spirit, if this be attended to at once.

Ichthyol is useful in all forms of **rheumatism**, its application in these cases being followed by a prompt relief of pain and a diminution of swelling, redness, and febrile reaction. Dressings kept constantly moist with a watery solution (10 to 20 per cent.) of ichthyol have proved of considerable value in **acute arthritis**, **muscular rheumatism**, **lumbago**, **sciatica**, and **gout**.

If an ointment be preferred the following may be used:—

**R** Ichthyol ..... f3ij-iv (8-16 c.c.).  
 Oil of citronella . gtt. xv-xxx.  
 Petrolatum or  
 lanolin ..... 3j (30 Gm.).

**M.**

In acute cases this may be gently rubbed over the affected parts and a piece of linen, spread with the same preparation, applied. This, in turn, is to be covered with cotton and a firm bandage. In sub-acute or chronic cases the ointment is best rubbed in well before applying the cotton and bandage. Ichthyol in olive oil (1:3) may be used in the same way. The effect of these applications, especially in sub-acute and chronic cases, can sometimes be heightened by giving ichthyol-sodium, 2 to 6 grains (0.12 to 0.4 Gm.), internally two hours after meals, either alone or in combination with an equal quantity of sodium salicylate.

In **acute rheumatism** ichthyol is helpful in the form of an ointment containing 1 dram (4 c.c.) each of ichthyol and salicylic acid to the ounce (30 Gm.) of lanolin, thickly applied to the painful joints and covered with absorbent cotton. In many cases of swollen and indurated cervical lymph-glands, ichthyol ointment will cause them promptly to subside. W. M. Gregory (Cleveland Med. Jour., July, 1907).

By reason of its analgesic property, ichthyol relieves the **pain** of diseases other than rheumatism, as well as the **pain of inflammatory swellings**.

In all forms of **rheumatism** a lukewarm 10 per cent. solution of ichthyol-glycerin may be used to moisten a gauze dressing for the affected part of the body. A hot-water bag should also be applied if heat is desired. An ointment consisting of equal parts of petrolatum and wool-fat, with 6 per cent. of ichthyol and 1 per cent. of menthol added, acts extremely well. In patients who cannot bear heat, ichthyol may be applied in glycerin ointment form, protected by a compress. Such an application is especially

effective in cases of painful swelling, which it will often subside overnight. It is recommended in **gonorrheal rheumatism**.

Added to the bath, ichthyol gives good results in **neuralgia**, particularly neuralgia of the back. To a full bathtub 2 ounces (60 c.c.) of ichthyol should be added. The value of a salt-water bath is heightened by previous application of ichthyol on the affected part. J. Hirschkron (Deut. Aerzte-Zeit., Nu. 1, 1907).

In **peritonitis** ichthyol has been applied pure, with a brush, over the whole abdomen. The surface is then covered by cotton, and that again by rubber tissue or thin rubber cloth to prevent evaporation. Pain, tenderness, tympanites, and fever subside under this treatment.

Scarpa treated a series of 150 cases of **pulmonary tuberculosis** with ichthyol, giving 20 to 200 drops daily of a watery solution of the pure drug (1:2) with the following results: 17 apparently cured; 50 notably improved; 32 improved to some extent; 28 not improved; 23 deaths. The beneficial action of the remedy was manifested first in the relief of cough, expectoration, and dyspnea, and later by an improvement in the general condition. Cohn calls particular attention to the remarkable effect of ichthyol on nutrition in this disease. He prescribes a mixture of equal parts by weight of ichthyol and water, and directs 4 drops to be taken well diluted three times daily. A little black coffee helps to cover the taste. The dose is to be gradually increased to 40 drops, which must be continued for a long time.

Ichthyol recommended in **pulmonary tuberculosis** in the early stages, **bronchitis** in all forms, and **pleurisy**. When given in doses as high as 20 minims (1.3 c.c.), three times a day, it tends to produce frequent bowel movements. It diminishes the discharge from the bronchi and hastens the return to a healthy condition, especially in patients who, having recovered from the acute bronchitis, still retain a cough, accompanied by profuse expectoration. Patients who have done well under ichthyol immediately begin to show a greater desire for food.

Because of its objectionable taste, it should be combined with peppermint water and a small amount of fluid-extract of licorice, and taken after meals. A convenient form of administration is a tablet made up with 5 minims (0.3 c.c.). Barnes (Med. Rec., Jan. 21, 1911).

In **bronchiectasis** with fetid expectoration, and acute bronchitis, good effects have been reported from ichthyol.

In **gynecological disorders** ichthyol has been used on account of its anodyne properties, its resolvent and absorptive action, and its kolyseptic powers. It has been claimed useful in the treatment of **chronic metritis**, inflammatory conditions of the tubes and ovaries, **erosion of the cervix**, **catarrhal endocervicitis**, **leucorrhea**, and **pruritus** of the genitals. Locally, a mixture of ichthyol, 1 dram (4 Gm.), and glycerin, 10 drams to 2 ounces (40 to 60 c.c.), may be applied on cotton tampons. Usually a 10 per cent. mixture is used. The remedy may also be rubbed in over the abdomen in ointment with lanolin (1 to 4 parts), or combined with soft soap (1 to 8). Suppositories containing 1 to 4 grains (0.065 to 0.26 Gm.) of ichthyol may be administered *per vaginam*. Ulcerations and erosions may be painted with pure ichthyol. For **leucorrhea** lavage with a 5 to 10 per cent. watery solution is appropriate, or a 5-grain (0.3 Gm.) suppository may be used night and morning, preceded by a copious hot-water irrigation. Doisey found a 1:4 ointment effective in **pruritus vulvæ** in pregnant women after other methods of treatment had failed.

In **acute cystitis** the lower part of the abdomen may be painted with ichthyol, pure or in a 30 per cent. ointment, to relieve the pain. The bladder may then be irrigated once or twice daily with a warm (86° F.) aqueous solution of ½ per cent. strength. In **chronic cystitis** a warm 1 per cent. solution may be used once daily.

**Gonococcal urethritis** is said to be amenable to intraurethral injections of a ½ to 3 per cent. watery solution of ichthyol or 0.04 to 0.2 per cent. silver ichthyolate. Neisser states that a 1 per cent. solution of ichthyol will destroy gonococci.

Ichthyol suppositories will usually cause inflammatory symptoms to disappear in

the course of a **gonorrheal prostatitis** (Lohnstein). The injection of a small syringeful of a 10 per cent. solution into the rectum three or four times daily has also been recommended.

In **acne** Unna advised the use of a 50 per cent. watery solution of ichthyol, well rubbed in on retiring, and washed off with warm soap-water in the morning; during the day a weak solution of bichloride of mercury was used. In addition to the external use of the remedy, Unna gave it internally in doses of from 8 to 30 grains (0.5 to 2 Gm.) daily. In **acne rosacea**, with a tendency toward eczema, mild applications may be used externally; where there is no such tendency, the remedy may be applied freely.

In **nervous eczema** ichthyol may be used internally and externally. For **erythema multiforme** and **lichen urticatus** Unna advised external applications of pure ichthyol or of strong solutions. In **intertrigo** a 10 per cent. salve or watery solution is beneficial; in **eczema marginatum** the same preparations are advised, with the addition of from 2 to 10 per cent. of salicylic acid.

Case of **erythema nodosum** in which the nodules on the legs were so numerous and painful for 8 days that the bedclothes had to be kept from the parts with a cradle. Steady application of ichthyol ointment for 48 hours reduced the swelling and pain so that the patient was able to walk at the end of that time. In **erythema induratum** many of the nodules are aborted with ichthyol ointment and the process subsides without necrosis. In **herpes zoster**, painting the vesicular groups with an ichthyol and collodion mixture (1 in 8) gives protection and soothes the inflammation. In **adenitis** the course of the swelling may be modified by nightly application of ichthyol ointment, and in many cases terminal necrosis and prolonged drainage can be avoided. J. H. Blaisdell (Ther. and Diet. Age, Feb., 1925).

Ichthyol has also been used with asserted advantage in the chronic stages of **keloid** and **lupus**. In the latter Unna recommended the following:—



- ℞ *Mercury bichloride* ..... 1 to 4 parts.  
*Sodium ichthyol-sulphonate* ..... 5 to 10 parts.  
*Distilled water*, enough  
 to make ..... 100 parts. M.

In *eczema* of the female genitals von Schlen recommends the following paste:—

- ℞ *Ichthyol* ..... 1½ to 2 parts.  
*Powdered starch*,  
*Flowers of zinc*,  
 of each ..... 12 parts.  
*Petrolatum* ..... 25 parts. M.

Itching in connection with eczematous conditions of the anal and genital regions can be greatly relieved by the use of an ichthyol wash ranging in strength from 1 to 2 drams (4 to 8 Gm.) to the ounce (30 c.c.) of water (Cantrell).

In *variola* an ointment composed of 10 parts of ichthyol, 60 of some fat, and 20 of olive oil and of chloroform or glycerin may be rubbed in three times a day as soon as the papules become visible.

In *erysipelas* ichthyol has seemed of great value, reducing the congestion, swelling, and pain, and apparently limiting the extension of the disease. The thickness of the skin determines, in a measure, the strength of the application to be used. The surface should be carefully washed and dried, and a salve (30 to 50 per cent.) made with lanolin or petrolatum then gently rubbed in. For use on the lower extremities Unna advised the following: Ichthyol and ether, of each, 1 part; collodion, 2 parts. Another formula is ichthyol, 2 parts, with ether and glycerin, of each, 1 part; or, instead of the foregoing, a 1:3 watery solution may be applied two or three times daily. The application should cover a zone of healthy skin around the affected area and always be made from without inward.

Reference to conclusions expressed by the Council on Pharmacy and Chemistry of the American Medical Association that ichthyol has no reducing power and does not precipitate the protein of the body cells, and that there is no satisfactory evidence that it has any therapeutic properties other than those of a feeble antiseptic demulcent and feeble astringent. The

author disagrees with the conclusion as to the relative lack of utility of ichthyol and cites as routine prescriptions containing ichthyol used in the Skin Department of the Massachusetts General Hospital the following: (1) Ichthyol, 1 dram (4 Gm.), and petrolatum, to make 1 ounce (30 Gm.); (2) ichthyol and distilled water, of each ½ ounce (15 Gm.); (3) ichthyol, 1 dram (4 Gm.), and flexible collodion, to make 1 ounce (30 Gm.). For *erysipelas* he cites as a successful treatment that instituted by J. C. White, consisting of application of the ichthyol ointment referred to and of the following lotion: Phenol, 30 grains (2 Gm.); alcohol and distilled water in equal parts, to make 8 fluidounces (240 c.c.). The lotion is applied ice cold every 15 minutes in the severe cases, throughout the waking period. In the milder ambulatory type it may be put on every hour or two. During the sleeping or rest periods, the ichthyol ointment is thickly applied. Under this routine, which can only be carried out properly on a very sick patient by a day and a night special nurse, the great majority of even the most desperate cases, with high temperature, delirium and unconsciousness, can be saved.

After 24 hours' application of ichthyol ointment on a localized area of *cellulitis* or spreading *lymphangitis*, the patient is very often 50 per cent. improved, with relative freedom from pain. If the area of cellular infection is small, the 50 per cent. ichthyol solution may be applied with a small camel's hair brush. In the first stage of a *boil*, ichthyol ointment markedly reduces the pain and will often abort the large necrotic processes. J. H. Blaisdell (*Ther. and Diet. Age*, Feb., 1925).

In *burns* of the first and second degrees subsidence of pain and congestion follows when pure ichthyol is painted on. Use of an ointment composed of equal parts of ichthyol, zinc oxide, and petrolatum also produces a happy effect. Leistikow, in burns of the first degree, uses a mix-

ture of 5 parts of zinc oxide, 10 parts of magnesium carbonate, and from 1 to 2 parts of ichthyol; and in burns of the second degree a mixture of 5 parts of zinc oxide, 10 of prepared chalk, 10 of starch, linseed oil, and lime-water, and from 1 to 3 of ichthyol. This is applied once daily. Where there is much inflammation the two preparations can be used at the same time, the burn being first dusted with the powder, and the paste applied over it.

In **frost-bite** Lange recommends the use of ichthyol in olive oil (3:20) as a paint; Heuss advises ichthyol in camphorated oil (1:4), rubbed in once or twice daily, and covered with cotton.

In **chilblains** (pernio) the use of an ointment of ichthyol (10 to 30 per cent.) or of equal parts of ichthyol and turpentine is attended with good results. Unna advises the use of a mixture of ichthyol, 5 parts; chloroform, 2 parts, and petrolatum, 3 parts. If the skin is broken the chloroform is omitted, and zinc ointment replaces the petrolatum with advantage.

In **furunculosis** solutions or ointments of ichthyol (10 to 50 per cent.) are equally efficient; the inflammatory symptoms usually promptly subside, and, if applied sufficiently early, ichthyol will abort the boils. With the external treatment calcium sulphide may be given with advantage in  $\frac{1}{4}$ -grain (0.016 Gm.) doses every two or three hours for twelve hours, then three or four times a day.

Pure ichthyol thickly painted on **furuncles**, which rapidly became softened and soon afterward opened. Every day the ichthyol was washed off and a new layer applied, after washing away the pus. The method proved equally successful in **sycosis barbæ** and **folliculitis** of the scalp. Several cases of **impetigo vulgaris**, **ecthyma**, and **eczema impetiginosum** were treated very satisfactorily with undiluted ichthyol. Hodara (Monats. f. Dermat., 1901; Merck's Arch., March, 1902).

In **pruritus** Lange advises the use of a mixture of ichthyol, 2 parts, in absolute alcohol and ether, of each, 9 parts; this is to be either painted on or rubbed in.

**Incised and postoperative wounds** dressed with pure ichthyol heal by first

intention. **Cracked nipples** heal well under a 20 per cent. ointment, but it must be wiped off before nursing. **Fissure of the anus** and other anal lesions do well under the use of pure ichthyol applied by means of a camel's hair pencil morning and evening and after defecation.

In **simple cellulitis** the author uses gauze saturated with a 20 per cent. solution of ichthyol in glycerin. This is applied to the parts and covered by a rubber cloth and cotton bandage. In a few hours the temperature falls, redness disappears, and pain is markedly decreased. In suppurating cases the gauze is pushed into the opening or openings, acting as a drain for the various pockets. The ichthyol solution may be injected directly into the **abscess cavities**. By its use one obtains better cicatrices, the danger of nerve implication is diminished, and loss of tendons and muscular attachments is avoided. A. Marro (Giorn. della Accad. di med. di Torino, No. 20, 1906).

In cases of **sore and cracked nipples** ichthyol ointment is a most healing application. It must be carefully removed before each nursing, then reapplied. W. M. Gregory (Cleveland Med. Jour., July, 1907).

Ichthyol suppositories are very useful in **rectal fissures**, **fistulæ**, and **hemorrhoids**. In **vulvar pruritus** the following formula (Barduzzi) proved effective: Ichthyol, 10 c.c. ( $2\frac{1}{2}$  drams); menthol, 1 Gm. (15 grains); dermatol, 5 Gm. ( $1\frac{1}{4}$  drams); petrolatum, 50 Gm. ( $1\frac{3}{8}$  ounces); two or three applications a day.

In **eczema** the following ointment may be used: Ichthyol, 10 c.c. ( $2\frac{1}{2}$  drams); lanolin, 40 Gm. ( $1\frac{1}{2}$  ounces); oil of bergamot, q. s. Chesner (Quinzaine therap., Aug. 10, 1908).

**Stings by venomous insects** may be advantageously treated by the application of pure ichthyol, or of a mixture of equal parts of ichthyol and lanolin. If swelling already exists, sheet rubber may be placed over the ichthyol and an ice-bag laid over the rubber tissue.

**Sprains and painful injuries about the**

joints do well under ichthyol; it should be well rubbed in on the surface of the injured parts, covered with cotton, and a bandage then firmly applied.

The pain in **parotitis** subsides rapidly when the parts are anointed with ichthyol-lanolin (1 to 2 per cent.) and covered with cotton. In many cases the use of undiluted ichthyol is indicated (Lange).

Ichthyol is an efficient remedy in many affections of the mucous membranes. Herz recommends a 2 per cent. solution of ichthyol as a gargle in **pharyngitis** and **tonsillitis** of almost every kind, except the follicular variety.

Ichthyol ointment, 2½ to 10 per cent., is advocated in the treatment of **scrofulous blepharitis** by Luciani.

Ichthyol in pills (¾ to 3 grains—0.048 to 0.2 Gm.—in twenty-four hours, rapidly increased to 10 or 15 grains—0.65 to 1 Gm.—in the day) is considered by many a valuable remedy in **whooping-cough**.

Gadde found that when ichthyol is given internally in **chronic alcoholism** the appetite returns and the **chronic gastric catarrh** is greatly improved. As secondary effects sleep is favored and general depression lessened.

In pills, capsules, or diluted with water, ichthyol affords immediate relief in **chronic catarrh of the stomach**, doing away with the discomfort attending the process of digestion, and relieving the accumulation of gases. J. Hirschkrone (Deut. Aerzte-Zeit., Nu. 1, 1907).

Ichthyol meets admirably the indications in the **catarrhal conditions of the stomach in alcoholic cases**. Patients object to taking it for a few days, because of the sulphuric eructations, but it arrests all gastric fermentation within three or four days if taken regularly, and then it is no longer objectionable.

There is no advantage in putting ichthyol up in capsules. It is best used in a 25 per cent. solution and this should be further diluted when it is given.

The following formula has been the most satisfactory in the author's hands:—

℞ *Ichthyolis* ..... ʒj (30 c.c.).

*Benzosulphinidi*,

*Sodii bicarbonatis*,

āā ..... gr. iv (0.26 Gm.).

*Aquæ cinnamomi*.. ʒij (60 c.c.).

*Aquæ*.....q. s. ad ʒiv (120 c.c.).

M. et ft. sol. Sig.: One teaspoonful before each meal.

G. E. Pettey ("Narcotic Drug Dis. and Allied Ailments," 1913).

Ichthyol in 1 per cent. solution used for lavage of the **stomach in ulcer and cancer** of this organ. The fluid is retained from ten to thirty minutes; the tube should not be withdrawn during this time; otherwise, vomiting may be induced. The toxicity of the stomach contents after a test-meal is greatly reduced already after 5 or 6 irrigations, and symptomatic improvement—unobtainable with ordinary lavage alone in the author's cases—follows 12 to 15 irrigations. A clinical cure in cases of gastric ulcer is obtained in a relatively short period. In patients with **hemorrhage**—not too severe—the ichthyolated water is given with addition of 1:1000 epinephrin solution; improvement follows day by day in the hemorrhage, which finally yields completely to the lavage, together with a suitable diet. In **inoperable cases of gastric cancer**, or where operation is refused, with the pylorus still patent, greater benefit is derived from the ichthyol lavage than from ordinary lavage or other drugs; the general prostration is distinctly lessened by the ichthyol. In hundreds of cases no untoward effect was noted, save occasionally—in cases of pyloric incontinence, in particular—mild diarrhea and slight pain. Constipation, where present, is always favorably influenced. A. Conti (Semaine méd., Jan. 21, 1914).

W. and S.

**ICHTHYOSIS.**—This is an hereditary or congenital, hypertrophic cutaneous disease, characterized by a general or localized dryness or scaliness of the skin, and a variable amount of papillary hypertrophy.

**SYNONYMS.**—Fish-skin disease; porcupine disease; xeroderma ichthyoides; ichthyose (F.); Fischschuppenausschlag (G.); ittiosi (I.).

**VARIETIES.**—Two varieties are usually mentioned: Ichthyosis simplex and ichthyosis hystrix, the difference being mainly one of degree, the latter being the severer form. A second classification is based upon the location of the disease, as ichthyosis cornea, follicularis, linguae, etc. A third is based upon certain characteristics: Ichthyosis nigricans, a form in which the scales assume a blackish tint; striata, a form in which large masses of scales are thrown off; serpentine, occurring upon the back and abdomen, characterized by thick, yellowish-gray scales, and nitida, a form in which the scales have a pearl-like appearance (Alibert).

**SYMPTOMS.**—While ichthyosis may be generally distributed over the entire surface of the body, it may, on the other hand, affect only circumscribed localities. In intensity it may vary from an abnormal dryness of the skin to a well-marked and disfiguring disease.

**Ichthyosis Simplex.**—The mildest form has been designated xeroderma, or dry skin, and is the form most often met with. In this form the entire surface is not only dry, but also wrinkled, harsh, and poorly nourished, giving it an unnatural and occasionally a parchment-like appearance. The subcutaneous fat is apparently deficient in amount, and this intensifies the natural lines and furrows and favors the production, more or less, of scales, which may be small, thin, and furfuraceous, or large, thick, and of the appearance of fish- or alligator- scales. The former are usually seen on the head, the latter on the extremities, where they appear as polygonal or diamond-shaped plates separated from each other by lines or furrows. Their attachment is usually firm in the center, more loose at the periphery. When thin they are white, but when thicker the color may vary from a dirty grayish white to yellowish green, brown, or even black, the coloration being due to dirt, extraneous matter, and pigment granules. The character and duration of the disease, the age of the patient, the fre-

quency of baths, and treatment will influence the extent and amount of the scales.

**Ichthyosis Hystrix.**—This variety is a severer or exaggerated form of the milder variety. The line of demarcation is not always well defined. It may be confined to localized patches or be unequally distributed over part or all of the surface, and, occasionally, over certain nerve tracts (ichthyosis linearis neuropathica). On the affected parts are found irregular or polygonal masses of all tints, generally greenish and black, separated distinctly by the natural lines and furrows of the skin. If these masses be removed a dry and shriveled skin is exposed, beneath which the sebaceous ducts can be seen distended by plugs of sebum. Occasionally the patches present a rough, papillary, or warty growth, having a horny, pointed, round, or spinous appearance, the latter often being several lines in length, and, from its resemblance to the quill of a porcupine, this form has been termed hystrix (Shoemaker). The favorite seats of these patches are around the elbows, the back, the neck, the axillæ, the umbilicus, the knees, and the ankles. The factors in the severity and the development of the disease are the age of the patient, the duration of the attack, and the attention given to the removal of the masses.

The disease, while it may be congenital, does not usually manifest itself until the first or second year, when it is apt to appear upon the surface of the limbs, especially the elbows and adjoining parts, the knees, and the ankles. The disease may be limited to the palms (i. palmaris) or soles (i. plantaris), or may spread over the whole body—the usual course. In the latter case the entire surface may have the appearance of being sprinkled over with meal, the thick, rough, and scaly condition being marked on the extensor surface, while the flexor surfaces are ordinarily normal in appearance. The scalp is rough, dry, and covered with furfuraceous or branny scales. The hair is rough, dry, brittle, and deficient in luster. The eyebrows and eyelids may be slightly scaly, but are usually unaffected, while the face may be covered with plates. As a rule, little or no itching is

present. The disease usually runs a chronic course, being worse in winter.

**DIAGNOSIS.**—The characteristic features of ichthyosis are the history of the disease, the harsh, dry skin, furfuraceous scales or polygonal plates, its distribution, the dull-white appearance of the skin, with absence of redness and itching, which are usually sufficient to differentiate it from other cutaneous disorders. Mild cases might, however, be confounded with squamous eczema, and localized patches of old cases with seborrhea. In the latter disease the skin is well nourished, and there is no papillary hypertrophy, and the scales cover the dilated ducts of the sebaceous glands.

**PATHOLOGY.**—In a well-marked case the epidermis is greatly thickened by the accumulation of heaped-up lamellæ. The mucous layer is hypertrophied and slightly separated from the stratum corneum. The papillæ are enlarged and infiltrated with cells. The blood-vessels are enlarged, but the glands and follicles remain unchanged. In more advanced cases Neumann, in addition to other hypertrophic changes, has found the vessels dilated, the cutis thickened, and its connective tissue condensed in bands; the hair follicles lengthened and containing lanugo; an increase in the external root-sheath; the glands dilated, especially the sebaceous, which assumed a cystic form, and the subcutaneous fat diminished. In some typical cases the epidermis was lamellated, the color varying from yellowish to dark brown, and the hair follicles and sebaceous glands were absent. Kaposi reported a case in which both the sweat and sebaceous glands were absent. The follicular orifices often contain horny plugs.

**ETIOLOGY.**—Ichthyosis is a congenital or hereditary disease developing about the first or second year of life. Schamberg attributes its cause to a developmental and nutritional defect of the skin, with disturbance of the sebaceous and sudoriparous functions.

Variations in the oiliness and dryness of the human skin are very considerable, though not often very noticeable. The lubricity of the skin is greatest in adolescence and early adult life, diminishing with age. Ex-

treme dryness of the skin is less frequent; it is met with in the old as a part of the general atrophy of the skin, with lessened glandular activity. It is also met with in very thin skinned persons, in whom the physiological exfoliation is not sufficiently compensated for by growth from beneath; the use of much or poor soap aggravates the condition. In certain persons this dryness of the skin becomes so marked as to be considered a disease—"ichthyosis." It commences in intrauterine life, but is usually in abeyance until some months after birth, after which it manifests itself with ever-increasing aggressiveness. Whatever may be its hidden cause, it must be regarded as an exaggerated development of epidermis, or a hyperkeratosis with atrophy of the deep layers of the rete mucosum. Any inflammatory appearances are probably accidental rather than inherent. Its essence consists in undue retention of the corneous layer, exfoliation being in abeyance. W. A. Jamieson (Brit. Med. Jour., Feb. 16, 1907).

**PROGNOSIS.**—The prognosis is unfavorable as to cure. Proper treatment may, however, afford considerable relief. Ichthyosis usually continues throughout the life of the patient, and he should be so informed.

**TREATMENT.**—The indications for treatment are the removal of the scales and the softening of the skin. Internal treatment is useless except when the patient is anemic or ill nourished. In the latter case tonics (iron, quinine, strychnine, arsenic, codliver oil) and nutritious diet, chiefly of milk and eggs; open-air exercise, and exposure to a moderate degree of sunshine will be beneficial.

Local treatment is the more important and beneficial. Frequent baths, either simple warm baths or alkaline baths (sodium bicarbonate, 4 to 8 ounces—125 to 250 Gm.—to each bath), and at intervals a hot-air or vapor bath, simple or medicated, are of value; in any case the bath should be followed by the inunction of some oily or fatty substance (olive oil, sweet-almond oil, petrolatum, benzoated

**lard**,—alone or combined with an equal part of **lanolin**,—**glycerin** and **rose-water**, **cocoanut oil**, etc.), the skin having been previously well dried.

**Resorcinol** favors continual desquamation and tends to leave the underlying surface polished and pliant. Combined with starch and glycerin (the **resorcinized glycerite of starch**), it proves beneficial in all cases if begun early enough and steadily persevered in. A **superfatted soap** to which **resorcin** and **salicylic acid** have been added must also be used. **Codliver oil** in small doses at night is of service. W. A. Jamieson (Brit. Med. Jour., Feb. 16, 1907).

The use of **thyroid gland** is advised by Henrichs (Norsk Mag. f. Laegevidensk., Oct., 1920), on the basis of the genealogy of 7 families in which an inherited taint manifests itself in idiocy and ichthyosis in different members of each generation and sometimes both in 1 person. In 1 instance the disease is traced back 200 years. The records show from 8 to 16 members in each family thus affected in the course of 4 or 5 generations.

Investigations in 21 cases in which the basal metabolism was ascertained led the writers to recognize a relation between ichthyosis and hypothyroidia. **Thyroid preparations** favorably affected this disease when the basal metabolism was below normal, but unfavorably as soon as the normal was reached. Krogh and With (Ugeskr. f. Laeger, May 17, 1923).

Case of ichthyosis transmitted to the males by mothers who did not have ichthyosis. **Thyroid extract** ameliorated the condition. Salvioli (Riv. di clin. ped., Jan., 1925).

Conclusion from basal metabolism studies that ichthyosis in the majority of cases is not due or related to hypothyroidism. Any improvement from **thyroid gland** must be explained by some other means than the direct action of thyroxin on the metabolism. F. B. Talbot and M. Henry (Amer. Jour. Dis. of Childr., June, 1925).

Ichthyosis is a manifestation of disturbed balance in the vegetative nerv-

ous system, to which treatment should be directed as well as to the skin. Castex and Camauer (Prensa med., Sept. 20, 1925).

In severe cases Schamberg advises **friction with soft soap** (sapo mollis), twice daily for four or five days, followed by a bath, and the inunction of the following:—

R *Acidi salicylici* ..... gr. xl (2.6 Gm.).  
*Olei cocos* ..... ℥viii (250 Gm.).  
*Olei lavandulae* ..... q. s. M.

Milton and Duhring recommended an ointment of **potassium iodide**, 10 to 20 grains (0.6 to 1.3 Gm.), and **lard**, 1 ounce (30 Gm.).

Shoemaker recommended an ointment of **benzoic acid**, 5 grains (0.3 Gm.); **rose-water ointment**, 1 ounce (30 Gm.), and **hydrous wool-fat**, ½ ounce (16 Gm.). Another favorite is **oil of ergot**, 3 ounces (90 Gm.), and purified **wool-fat**, 1 ounce (30 Gm.).

In ichthyosis hystrix, **caustics**, the **knife**, or the **Paquelin cautery** may be necessary to remove the hypertrophic tissue (Schamberg).

**Eucerin**, a few ointment base, obtained from wool-fat, is recommended by Unna for the treatment of ichthyosis. **Sulphur**, **resorcin**, **salicylic acid** and **naphthol** are of proven value.

**Glycerin**, as a useful remedy in ichthyosis, was first recommended by Lailier and has become the classical method of treatment in France, used either in the form of an ointment or as a 10 per cent. glycerine and water application after a daily bath with soap. The disadvantage of this latter method, which has otherwise much to recommend it, is an unpleasant feeling of stickiness and refrigeration.

**Eucerin** was tried in the form of a **eucerin cold cream** after baths with the addition of **salicylic soap**, and produced a gratifying result. Editorial (Boston Med. and Surg. Jour., June 20, 1912). W.

**ICTERUS.** See LIVER, DISEASES OF.

**ILEUS.** See INTESTINES, DISEASES OF: INTESTINAL OBSTRUCTION.

**IMPETIGO CONTAGIOSA.**

**—DEFINITION.**—This is a contagious, acute, and inflammatory disease of the skin, characterized by flat, superficial, and usually discrete vesicles, which soon become pustular, then dry as thin crusts, which are soon shed, leaving a temporary reddish stain.

**SYMPTOMS.**—This is one of the commonest of the transmissible diseases of the skin. It is common in schools and institutions for children, where it often rapidly disseminates, especially in children under 10 years of age. It may also occur in adults, several members of a family being often affected.

It is characterized by pinhead to pea or finger-nail sized, round vesicles or blebs, which tend rapidly to pustulation. These are thin-walled, superficial, and flat. Their fluid is at first a clear serum, but in twelve to twenty-four hours it becomes puriform, drying into ochre-yellow or brownish, friable and crescentic crusts, surrounded by practically no areola and which appear to be "stuck on." The eruption is discrete, although rarely it may coalesce. Under the crust is a superficial erosion, which soon heals after shedding, the former leaving a temporary reddish stain, which fades.

The face, neck, and hands are the regions most commonly affected. In children paronychia, due to contact of the fingers with the facial lesions, is common. The mucous membranes are nearly always exempt. The eruption may be profuse or consist of a few lesions. When profuse, there may be slight rise of temperature.

**ETIOLOGY.**—Impetigo contagiosa may be transmitted from one individual to another by direct contact or through the mediation of certain articles. Moreover, it may be transferred in the same individual from one part of the body to another. In other words, this affection is both contagious and autoinoculable. It is further generally recognized that the disease is due to the invasion of the skin by the common pyogenic cocci or organisms morphologically indistinguishable from them. There is, however, considerable difference of opinion as to whether the offending agent is the *Staphylococcus aureus* or the *Streptococcus pyogenes*.

The staphylococci are nearly always present in the fluid of the vesicles, but investigations have pointed out that they may develop secondary to the streptococci. Clinically, one fact is obvious, namely, that the mere presence of staphylococci upon the skin does not suffice to produce impetigo, for they are to be found normally in the integument. Furthermore, all forms of pus (although practically always containing staphylococci) are not capable of determining an impetigo. Either the staphylococci are not the specific cause of impetigo, or they require a heightened virulence to enable them to produce the disease.

In armies there are types of impetigo which present features not commonly seen in civil life. These include a form of streptococcal impetigo commonly met on the buttocks and lower limbs, a type which causes a great deal of destruction of tissue. W. H. Brown (*Brit. Jour. of Dermat. and Syph.*, Dec., 1917).

It is possible that the soil itself may play some rôle in the production of the disease. In furuncles this is admittedly the case, and boils represent merely a deeper pyogenic infection. Impetigo is far more common in the poor than among the wealthy classes. Consequently it is a disease much more frequently seen in dispensary practice than in private practice. It is commonly observed as a complication of pediculosis of the scalp, the itching leading to scratching and the latter to pyogenic infection. Purulent discharges from the nose, eyes, or ears may give rise to the disease. It is common in infants during the summer months, when it occurs as a complication of prickly heat, with furunculosis frequently superadded. It is engrafted upon the vaccine wound and the multiplicity of lesions may lead to a suspicion of generalized vaccinia. The bearded portion of the face is commonly affected when the disease occurs in men. This region is frequently abraded in the process of shaving and offers easy ingress to micro-organisms. The focus of dissemination in many epidemics is traceable to certain barber-shops, and in such cases it is usually found that the care of the instruments employed is defective.

It is not, however, the "barber's itch," which is due to ringworm (Schamberg).

**TREATMENT.**—According to Schamberg, mild cases of impetigo frequently undergo spontaneous cure in ten days or two weeks, while other cases tend to run on indefinitely. It is important before applying any medicament to the skin to remove the crusts, for it is manifestly impossible to bring the application into contact with micro-organisms which are securely protected by an overlying and impenetrable crust. The crusts are detached by washing with soap and water, after previously softening with oil or petrolatum. Mild antiseptic remedies are now applied to the skin.

Systematic removal of the crusts and application of dilute nitrate of mercury ointment usually suffices. Early application of 2 per cent. iodine often aborts the development of a spot. A weak fomentation of lysol or boric acid, with the part kept well covered, is in many instances very efficacious. Simey (Lancet, Apr. 15, 1922).

In chronic cases, autogenous vaccines, yeast, and horse serum may be useful adjuvants, but must be used with caution in order not to induce too marked a reaction. Balzer (Paris méd., Sept. 17, 1921).

It is desirable to rid the patient of this very disfiguring affection with the greatest possible expedition. One of the best methods is to frequently apply during the day the following lotion:—

℞ *Hydrargyri bichloridi* ..... gr. j (0.065 Gm.).  
*Glycerini* ..... f3j (4 c.c.).  
*Spts. vini rectif.* . f3j (30 c.c.).  
*Aquæ* ... q. s. ad f3iv (120 c.c.).

and to supplement this with the nightly application of some such ointment as:—

℞ *Hydrargyri ammoniati* ..... gr. x-xv (0.6-1 Gm.).  
*Pulv. amyli*,  
*Pulv. zinci*  
*oxidi*, of each 3ij (8 Gm.).  
*Petrolati* ..... 3ss (15 Gm.).

Sometimes lesions upon the face will yield more quickly to an ointment made up of:—

℞ *Resorcini* ..... gr. xv (1 Gm.).  
*Lanolini*,  
*Petrolati* ..... aa 3ss (15 Gm.).

Or, to a lotion of resorcin:—

℞ *Resorcini*,  
*Acidi borici* .... aa gr. xl (2.6 Gm.).  
*Glycerini* ..... f3j (4 c.c.).  
*Alcoholis* ..... f3ss (15 c.c.).  
*Aquæ* ..... q. s. ad f3iv (120 c.c.).

When the patches are upon covered surfaces they may be painted twice a day with a 10- to 20- grain (0.6 to 1.3 Gm.) solution of nitrate of silver.

It is highly important to caution patients against touching the lesions, for by this means healthy areas of skin are inoculated. It is also desirable to avoid pillow infection at night by covering the affected parts, when possible, with a bandage.

Eruptions following impetigo contagiosa are frequently met with in children. They may occur sporadically or in epidemic form (especially in schools); lesions of impetigo may also be present. This is a degenerate form, or a sequel to impetigo, and is streptococcic in nature. It is easily cured with:—

℞ *Tannini*,  
*Calomelanos* .aa 0.3 Gm. (5 grs.).  
*Petrolati* ..... 30 Gm. (1 oz.).

To be applied to the affected skin.

When the disease recurs, it may be due to associated impetigo lesions, which should be discovered and treated. In such cases a strong solution is required:—

℞ *Zinci sulphatis*.. 7 Gm. (1¼ drs.).  
*Cupri sulphatis*.. 3 Gm. (¾ dr.).  
*Aq. camphoræ* . 300 Gm. (10 oz.).

A tablespoonful to be added to the water used in washing the face.

When the skin is red, with the surface mummified, or slightly scaly, this condition is most frequently due to the abuse of soap on the face. The following is useful:—

℞ *Petrolati*,  
*Adipis lææ*,  
*Aquæ rosæ*,  
 aa ..... 10 Gm. (2½ drs.).  
*Zinci oxidi* .... 4 Gm. (1 dr.).

Apply once or twice daily.



Sabouraud (Jour. des sci. méd.; N. Y. Med. Jour., Nov. 30, 1907).

Case of impetigo contagiosa in which there was a scattered, crusted eruption of the face and neck. Both nostrils were intensely red, crusted, and discharging an acrid serum. Conjunctivitis of the right eye was also present. For the face and nostrils an ointment was ordered of the following composition:—

*R* White precipitate  
ointment ..... 3iv (16 Gm.).  
Zinc ointment .... 3j (30 Gm.).  
M.

Compresses of a hot, saturated solution of boric acid were directed to be used on the eye; also in the nostrils. The outer surface of the eyelid did not improve under this treatment and a paste of the following ingredients was applied:—

*R* Starch,  
Zinc oxide of each 3j (4 Gm.).  
Naphthalin ..... 3ij (8 Gm.).

M. Sig.: Use at night and wipe off with olive oil in the morning.

Under the application of this powder and the dusting of calomel in the eye three times a day the condition of the patient was improved. Montgomery (Jour. Cut. Dis., Sept., 1910).

In infants, who are made restless by ordinary protective dressings, which require frequent changing, the following preparation is both effectual and convenient in that no covering dressing is required:—

*R* Fuchsin ..... gr. xv (1 Gm.).  
Absolute alcohol .. 3iiss (10 Gm.).  
Phenol ..... gr. lxxv (5 Gm.).  
Distilled water ... 3iiiss (100 Gm.).  
M. et ft. solutio.

In treating the skin lesions the superficial, friable part of the crusts is first removed by means of compresses soaked in a zinc sulphate solution:—

*R* Zinc sulphate .... gr. xv (1 Gm.).  
Distilled water ... 3vij (200 Gm.).  
Fiat solutio.

Each projecting crust is then individually soaked, by direct pressure of cotton, with the fuchsin solution. On allowing the solution to dry thoroughly, a red, glossy, impervious covering is formed. Daily applications are made. H. Triboulet (N. Y. Med. Jour., from Nourrisson, Jan., 1913).

In 6 out of 7 cases in which a usually effective ointment of ammoniated mercury of  $\frac{1}{8}$  the usual pharmacopeial strength failed, the writers found a staphylococcus to be the cause of the lesions. In such cases a 5 per cent. solution of gentian violet in 20 per cent. alcohol proved curative. The unruptured vesicles were opened, old scabs removed, and the entire area (in 1 case  $\frac{1}{4}$  of the body) painted with a swab saturated with the gentian violet. When dry, a thick layer of vaselin or boric acid ointment and a bandage were applied, the latter being left undisturbed for 2 days. The average time for cure was 6 days. In streptococcic cases gentian violet and ammoniated mercury are of equal value. One streptococcic case recurred until an autogenous vaccine was used. D. T. Smith and E. L. Burky (Johns Hopk. Hosp. Bull., Mar., 1924).

### IMPETIGO HERPETIFORMIS.

**DEFINITION.**—This is a rare disease, occurring generally in puerperal women, and characterized by the appearance of miliary pustules disposed in clusters or annularly. It is generally fatal.

**SYMPTOMS.**—The lesions described above occur in successive crops and especially in the genitocrural region, the inner and posterior aspect of the thighs, though it may invade the whole body. Their development is accompanied by chills and a temperature which recall a septicemia or pyemia, with which the disease is closely associated. The tongue is dry and there is vomiting, diarrhea, albuminuria, delirium, and other symptoms of grave constitutional disturbances, which increase in severity, the patient dying from exhaustion.

**ETIOLOGY.**—The disease is evidently an infection of a septicemic type. Al-

though several organisms have been incriminated, the cause of the disease is still obscure.

**TREATMENT.**—Practically all cases reported, about 20 in number, have died. Those which survived were kept in continuous bath. Linsen recently reported a bona-fide case in which serum from a pregnant woman had been injected. S.

## INCONTINENCE OF URINE.

See ENURESIS.

## IMPOTENCE. — DEFINITION. —

Impotence, or impotency, signifies inability to carry out properly the sexual act, *i.e.*, to have sexual intercourse in a normal manner, whether actual inability to supply spermatozoa exists or not. Castration after puberty fails to abolish potency, except after considerable time. Intromission of the penis by virtue of its erect condition and a subsequent ejaculation of fluid are the 2 essential conditions of potency.

**VARIETIES AND CAUSES.**—True impotence is due to a physical deformity or disease, while *false* impotence is of psychic origin only. The former type is less common, and includes cases due to a sharply bent condition of the penis when erect, tumors of or near the penis, elephantiasis of the genitals, pronounced hypospadias or epispadias, tight urethral stricture causing dribbling of semen after subsidence of erection instead of ejaculation during erection, posteriorly directed ejaculatory ducts causing discharge of the semen into the bladder, abnormal or very small size or absence of the penis, a tight phimosis, and a hydrocele, ankylosis of the thigh near the abdomen, or excessive abdominal panniculus rendering the approximation necessary for intercourse impossible. True impotence may also be caused by organic disorders of the nervous system preventing erection or ejaculation or both, or by old age. A temporary true impotence may occur in the drunken state or chronic alcoholism, in drug habitués, from excessive use of tobacco, from marked lowering of vitality, and from continued sexual abuse. A eunuch is often impotent, but not necessarily so.

False impotence may even be merely an attitude of the mind. It may arise from some emotional shock, or be due to indifference toward the partner or to sexual perversion. Many cases are the result of incomplete or evanescent erection and premature ejaculation—a frequent consequence of excessive sexual excitation. In *nervous* impotence, the individual, though not lacking in sexual desire or energy, and in fact sexually hypersensitive, is unable to have a satisfactory erection in actual intercourse, the erection being inhibited by excessive excitement, the memory of a previous signal failure in coitus, perhaps the result of some external condition not under his control, or the fear of impotence *per se* engendered by the reading of quack advertisements. In some other instances, the impotence is imaginary, the subject being merely less powerful sexually than others with whom he compares himself.

**TREATMENT.**—In true impotence this consists in correction, in so far as possible, of the deformity, infection, intoxication, or other condition causing it. Where sexual excess or overexcitement is a factor, rest of the function for a time is indicated. To excite the sexual function, the measures available include an ample diet, rich in phosphorus; cold baths; sea bathing; hot or cold affusions locally; counterirritation with mustard; general massage or rubbings with a brush, and excitant drugs. Strychnine is of recognized value. Phosphorus,  $\frac{1}{40}$  grain (0.0015 Gm.) a few hours before intercourse, later cautiously increased, directly increases sexual desire (Keyes). Yohimbine, ergot, iron, and cannabis indica have also been recommended. Cantharis, in doses of 5 to 8 minims (0.3 to 0.5 c.c.) or less of the tincture, with or without full doses of nuxvomica and tincture of ferric chloride, is likely to prove useful in impotence resulting from sexual excess, but tends merely to excite erection without influencing sexual desire, and must be used with caution. In impotence due to organic impairment of the testicles, testicular extract is of service.

In nervous impotence the probable emotional cause of the condition should be ascertained, and the individual so reassured

and encouraged that full use of what sexual power is available will be favored. Wrong impressions should be corrected, and the exact sexual capacity inquired into, that he may be warned of the risk attending excessive activity, and relieved of disappointment, even after prolonged sexual rest. A stay in the country, preferably with plenty of exercise together with tonics, is often of value to eliminate former pernicious mental associations or habits and restore confidence.

Mechanical devices should be used only in simple debility of erection in slight relative impotence, and not in premature ejaculation in neurasthenia. The penis may be wound with an elastic zinc oxide bandage not covering the glans. Furbringer (*Rev. españ. de med. y cir.*, May, 1924).

### INDICANURIA.—DEFINITION.

—Indican, in small quantities, is a usual constituent of the urine; under certain circumstances, however, the amount is so large as to merit the designation of indicanuria.

**SYMPTOMS.**—Normal urine contains very small quantities of indican; about 0.0045 to 0.0195 Gm. is excreted in twenty-four hours; different animals secrete much more, horses about twenty times as much. Urine containing much indican is dark-colored, brown to black; in rare cases indigo is deposited as a blue powder.

The presence of indican in excess in the urine is demonstrated by different tests.

**Heller's Test.**—By the addition of nitric acid a blue-violet ring is formed at the line of contact of acid and urine.

**Jaffé's Test.**—Equal volumes of urine and hydrochloric acid are mixed in a test-tube; a few drops of a solution of sodium hypochlorite are added and the mixture is shaken. The blue color of indigo will then appear. Stokvis proposes to add some drops of chloroform, in which the indigo dissolves.

**Senator's modified Jaffé's test** is applied as follows: Ten to 15 cm. of urine are mixed with an equal quantity of concentrated hydrochloric acid; 3 to 5 c.c. of chloroform and 1 drop of saturated solution of chlorinated lime are added and the

mixture is shaken. The chloroform is colored blue when indican is present in excess.

**Daland's Test.**—To 10 c.c. of filtered urine add 1 drop of a 1 per cent. solution of potassium chlorate, then 5 c.c. of chloroform, and lastly 10 c.c. of pure fuming hydrochloric acid (sp. gr., 1.19). It is needful to add the reagents in the order named, and to mix the contents of the test-tube by repeatedly pouring the contents from one test-tube into another. If the contents of the test-tube be now permitted to settle, the chloroform will be found at the bottom, colored blue with the indigo, and after some time the indigo will crystallize out in small cubes with rounded corners. If the whole of the twenty-four hours' urine has been used, and the amount of the indican is at all considerable, the amount of indigo may well be ponderable: in one case, by no means a bad one at that, 23 mg. of indigo was thus obtained, as the equivalent for the twenty-four hours' indican excretion.

**Holland's Test.**—J. W. Holland uses the following method: To a test-tube one-quarter filled with urine he adds the same amount of concentrated hydrochloric acid to liberate the urinary indican, and then, as oxidizer, a piece of sodium perborate as large as a pea; he then gently agitates the effervescing mixture to dissolve it. If the amount of indican is large the urine turns faintly blue. To concentrate the color 1 c.c. of chloroform is added; the tube is then closed with the thumb and gently shaken at least two minutes. The chloroform separates as a layer at the bottom, varying in blueness according to the proportion of indican. If the patient is taking iodide of potash, the violet blue of free iodine may cause a fallacy; and if such is suspected, pour off the acid fluid and add potassium hydroxide to the chloroform, when the color due to iodine will disappear and the indigo blue remain. With this test he has uniformly obtained a distinct indigo-blue reaction in the presence of from 1 to 5 mg. indoxyl salts per liter.

**Obermayer's Test.**—The urine is precipitated by the addition of a solution of acetate of lead; the filtrate is treated by the addition of concentrated hydrochloric

acid and a few drops of a 2 to 4 per 1000 solution of perchloride of iron; the mixture is shaken with chloroform.

Askenstedt has evolved (1912) from the Obermayer test a modification which, though still possessing certain imperfections, yet combines the advantages of the ordinary quantitative tests for indican with a greatly simplified technique, rendering it the one best adapted to the requirements and limitations of the medical practitioner. The test is carried out as follows: To 10 c.c. of urine in a test-tube add 10 c.c. of the ferric chloride solution and mix by inverting the tube once; then add quickly 8 c.c. of chloroform, and extract the indigo in formation by shaking the tube 400 times, holding it in a horizontal position. After this let the chloroform fall to the bottom of the tube, then pour off most of the supernatant fluid, fill the tube nearly full with water, invert it a few times to wash the chloroform, and let this again precipitate in the tube, and pour off most of the water. Repeat twice this process of washing, taking care that no chloroform escapes with the wash water, and allowing not more than 2 or 3 c.c. of the last wash water to remain over the chloroform. Now add from 13 to 15 c.c. of alcohol and mix by shaking. A clear blue fluid should result. If hazy, add 1 or 2 c.c. more of alcohol until the fluid clears up. Compare the color of this fluid with an equal quantity of a standard solution of indigo blue in the second test-tube by holding the 2 test-tubes in front of a white surface. This standard solution is made by pouring into the empty second tube a quantity of water equal to the amount of the fluid in the first tube, and then dropping the stock solution of indigo blue into the water, inverting the tube after each drop, until both solutions have the same amount of blue color. If this requires 4 drops of the stock solution the percentage is 0.0004; if 5 drops, 0.0005; if 6 drops, 0.0006, etc.

The indican extract will often prove slightly greenish. By adding one or more drops of the picric acid solution to the standard solution in the test-tube, this can be made to conform to the color of the extract. Albumin or bile in the urine will not interfere with the estimation;

sugar reduces it. To compensate for indican not collected by the chloroform and the small amount lost in the washings, add 20 per cent. to the final result. Urine containing 0.002 per cent. or more of indican, or giving a blackish extract, should be diluted with equal quantity of water and retested.

Quantitative tests have been indicated by Jaffé and Salkowski, advantage being taken of the bleaching powers of hypochlorite of calcium, a standard red solution of this salt being used to effect the complete decoloration of the indigo.

**Barberio's Test.**—Barberio uses sulphurous acid, in the form of sodium sulphite dissolved in distilled water in the proportion of 1:2000. To 5 c.c. of filtered urine, a few drops of this solution are added, the mixture shaken, and then mixed with 5 c.c. strong HCl and 2 c.c. chloroform. The chloroform takes on a blue color, whose intensity depends, in the absence of iodine, upon the amount of indican in the urine. If iodine is present, the addition of a crystal of sodium thiosulphate suffices to decolorize it.

**ETIOLOGY.**—By the decomposition of proteids indol is formed, which is absorbed in the intestine and oxidized in the blood, forming indoxyl.

Indicanuria is one of the most important conditions in connection with clinical medicine. Indican was discovered by Prout, in 1840, and blue substances have been recorded in the urine from the time of Hippocrates to the present. Baumann and Breiger were the first to determine accurately the composition of indican. Baeyer demonstrated that a more simple substance, indol, was the antecedent of the more complex body known as indican. Nencki and others demonstrated beyond a question of doubt that indican is always the result of putrefactive fermentation. Animal proteids are more likely to undergo putrefactive fermentation than the vegetable class. Vegetable proteids are much more difficult of digestion than are the animal class; hence they are less economic, and often detrimental to the system.

Senator has proved conclusively that bacterial action is required to produce putrefactive fermentation in connection with the production of indican. The sulphur atom in connection with the formation of indoxyl-potassium sulphate comes from the proteid molecule as the result of its oxidation reduction. Indican is primarily formed in the intestinal tract, and not in the liver. Numerous toxins are formed at the same time and are absorbed. W. H. Porter (Med. Rec., June 15, 1907).

Trauma to the intestinal wall is sufficient to produce indican if sufficiently prolonged and severe, whether it occurs through mechanical injury in operation, adhesions, or coprostasis. Enteroptosis may produce it and exaggerated intestinal putrefaction with its consequences. The constant finding of indican in constipation complicated with cardiac insufficiency is notable.

Indican exists only in extreme hepatic insufficiency and in gastric hyperacidity, especially with gastric and duodenal ulcers. In several cases of ozena and dental caries indicanuria was conspicuous, though there were other signs of pathological conditions. The patients evidently swallowed more or less virulent pus in their sleep, which furnished the source of intestinal infection and putrefaction, the stomach being empty and not containing any hydrochloric acid. The insufficiency of pancreatic juice, with its consecutive increase of intestinal putrefaction, was shown in 2 cases of carcinoma of the pancreas with ever-present indican. Bile insufficiency as a cause of indicanuria was not proven by the author's studies. About 50 cases of icterus with complete occlusion of the common duct showed indicanuria in only 10 cases. In 3 of these there was drainage through a cholecystotomy, with acholic stools. A. Baar (Jour. Amer. Med. Assoc., Nov. 5, 1910).

Indican in the urine found in 8.2 per cent. of 338 examinations in newborn infants. It could not be asso-

ciated with any pathologic findings, and may be considered physiologic. Bonar (Amer. Jour. Dis. of Childr., Apr., 1921).

Indicanuria found in about 25 per cent. of apparently normal persons. It was present in 94 per cent. of amebic dysentery cases, but was absent in 5 cases of bacillary dysentery. R. M. Gordon (Ann. of Trop. Med., Dec. 21, 1923).

Studies in guinea-pigs enabled the writer to show that indican is present in the urine only when the colon bacillus is present in the feces. Distaso (C. r. Soc. de biol., June 20, 1924).

Of 146 dermatologic patients, it was found that 97 per cent. showed indicanuria on admission, while almost all showed a return to normal before discharge. The only connection suggested was between the extent of the eruption and the degree of indicanuria. Constipation did not appear to influence the indicanuria. Krone and McCaw (Brit. Jour. of Dermat. and Syph., Nov., 1924).

When excreted in the urine it is combined with sulphuric acid and excreted as indoxylsulphuric potassium-indican. This salt may be isolated as rhomboid, white crystals, which are soluble in water and hot alcohol, hardly soluble in cold alcohol and not at all in ether; by heating it with hydrochloric acid it is divided into sulphuric acid and indoxyl, which in presence of oxidizing substances gives indigo. By fermentation of urine containing much indican, indigo is also formed.

Indicanuria is ordinarily dependent on decomposition of the intestinal contents consequent upon constipation or occlusion of the intestinal tract, *especially of the small intestine*, while occlusion of the large intestine does not cause it.

Urinary indican is a product of intestinal putrefaction. There may be putrefaction without the production of indol, but there cannot be indicanuria without putrefaction. A maximum excretion of indican, that is, an amount which on Folin's scale gives an index of 100 or over, may be safely relied on to indicate excessive intestinal putrefaction, and espe-

cially the intoxication arising therefrom. A maximum reaction which gives an index under 100 may be significant, but its interpretation should be strictly guarded by the general condition of the patient, that is, by the oxidizing and excretory capacity. A heavy indican reaction which markedly subsides under treatment undoubtedly indicates a lessening intoxication, but minor variations in the color index have no significance at present. No interpretation can be placed on a negative reaction, too many unsolved factors entering into the problem. Houghton (Amer. Jour. Med. Sci., April, 1908).

In the conditions of hunger the albuminous secretions of the bowels are decomposed and form indol; newly born infants do not produce indol, because their intestines do not contain bacteria.

Indican is found in cases of decomposition of pus, as in putrid empyema, putrid suppurations, etc.

Some persons are resistant to the poisons of which this reaction is an indication. Conversely, there are, no doubt, individuals who are particularly susceptible, and react violently to the poisons generated by autointoxication. This reaction may occur in the form of various cutaneous diseases, as an erythematous, vesicular, papular, or bullous condition. Engman (Jour. of Cutan. Dis., April, 1907).

It has also been observed in different diseases, especially of the stomach and the bowels: carcinoma of the stomach, gastric ulcer, acute and chronic gastric catarrh, cholerae nostras and Asiatica, peritonitis, etc.

In the 2092 cases which form the basis of the writer's monograph on indicanuria, cases *with* constipation showed a positive indican test 736 times, and a negative test 820 times, while those *without* constipation showed positive tests 2600 times, a negative test 2503 times. This means that the non-constipated patients showed indicanuria much oftener than the constipated ones.

Another familiar claim as to etiology of indicanuria was the statement that abnormal quantities of indol in the feces, produced by abnormal putrefaction, cause the excretion of indican in the urine. But there certainly is no necessary relation between indicanuria and fecal indol, for the investigation showed that the feces contained indol, while the urine showed no indican and *vice versa*. This fact proves that it is not alone the quantity of nitrogenous putrefactive substances within the intestinal tract which causes indicanuria, and that there must be some other reason for the entrance of this material into the circulation besides the mere overproduction of the same within the intestinal tract. The writer found in many cases of diarrhea, which represent the attempt of the organism to rid itself of the enterogenous putrefactive substances, excessive indol in the feces and no indican in the urine.

As to the practical results of the study: Instead of guessing as to the diagnosis in those cases which come under observation with definite gastrointestinal symptoms, the twenty-four-hour urine should be regularly tested for indican and, after having made 20 or 30 such tests, we should, with due consideration of all other clinical symptoms, be able to make a diagnosis. One single test has no value at all and it is only the repeated examination of the urine for indican which will throw additional light on those obscure lesions of the gastrointestinal tract which for years may not show any definite symptoms.

If these tests are made, the indicanuria cases may be divided into three types: 1. Transitory, due to some transitory anatomical lesions or temporary insufficiency of gastrointestinal secretions (psychic). 2. Constant, due to permanent or progressive anatomical lesions of the gastrointestinal tract, or to permanent insufficiency of the gastrointestinal secretions (earmarks of hypoplastic constitutional anomaly). In these

## INDICANURIA AS DIAGNOSTIC SIGN. (WILLIAM H. PORTER.)

**Test.**—Place in a test-tube equal quantities (10 c.c. of each) of urine and chemically pure concentrated hydrochloric acid. To this mixture add 3 drops of a  $\frac{1}{2}$  per cent. solution of potassium permanganate. Then add a small portion of chloroform, 1 or 2 more drops of the permanganate solution, and a few drops more of chloroform, or a total of 5 c.c. of chloroform, and shake vigorously for a few seconds. Compare results with opposite color scale.

**Fig. 1.**—In the absence of either extrinsic or intrinsic putrefaction the chloroform will settle to the bottom of the fluid in the test-tube and remain pure white. This indicates a perfectly normal state.

**Fig. 2.**—If there is a simple putrefactive process of either form with little or no toxic infection, but in which the indoxyl potassium sulphate has found its way into the urine, there will be formed first, upon addition of the acid and permanganate solutions, a purplish cloud in the fluid in the test-tube. Upon addition of the chloroform the purple quickly gives place to a decided deep indigo blue. This is due to a precipitation of small particles of indigo blue resulting from the oxidation of indoxyl potassium sulphate into the substance called indigo and its precipitation by the chloroform. In the absence of all other pigments and toxic products the deposited chloroform and indican remain deep blue in color. This result is indicative of simple indicanuria.

**Figs. 3 and 4.**—When pronounced toxemia is associated with the putrefactive process, there is often a breaking-up of the hemoglobin and the formation of a red pigment; or, there may be some occlusion to the internal ends of the bile-ducts. When this is the case the bile-pigments, acids, and salts re-enter the blood and finally the urine. Various toxins also enter the urine. When this is the case the pigments or toxins interfere with this test reaction as just described; that is to say, these substances are added to or precipitated with the indigo produced by the oxidation reduction of the indoxyl potassium sulphate. Now, instead of the sharp and distinct blue reaction, a dirty blue, purplish, or reddish color is obtained, the shading depending in a large measure upon the form of pigment or toxin entering into the combination. This result indicates a more or less complex toxemia in addition to the simple indicanuria.

**Fig. 5.**—With a more marked change in the hepatic cells and the development of a somewhat pronounced occlusion of the internal ends of the bile-ducts, varying shades of green will be noticed in the deposited chloroform. This always indicates that a considerable amount of the bile-pigments, acids, and salts has re-entered the blood and been excreted with the urine. This is especially so in reference to the biliverdin.

**Fig. 6.**—With a still more pronounced hepatic involvement the color will be a still more pronounced green.

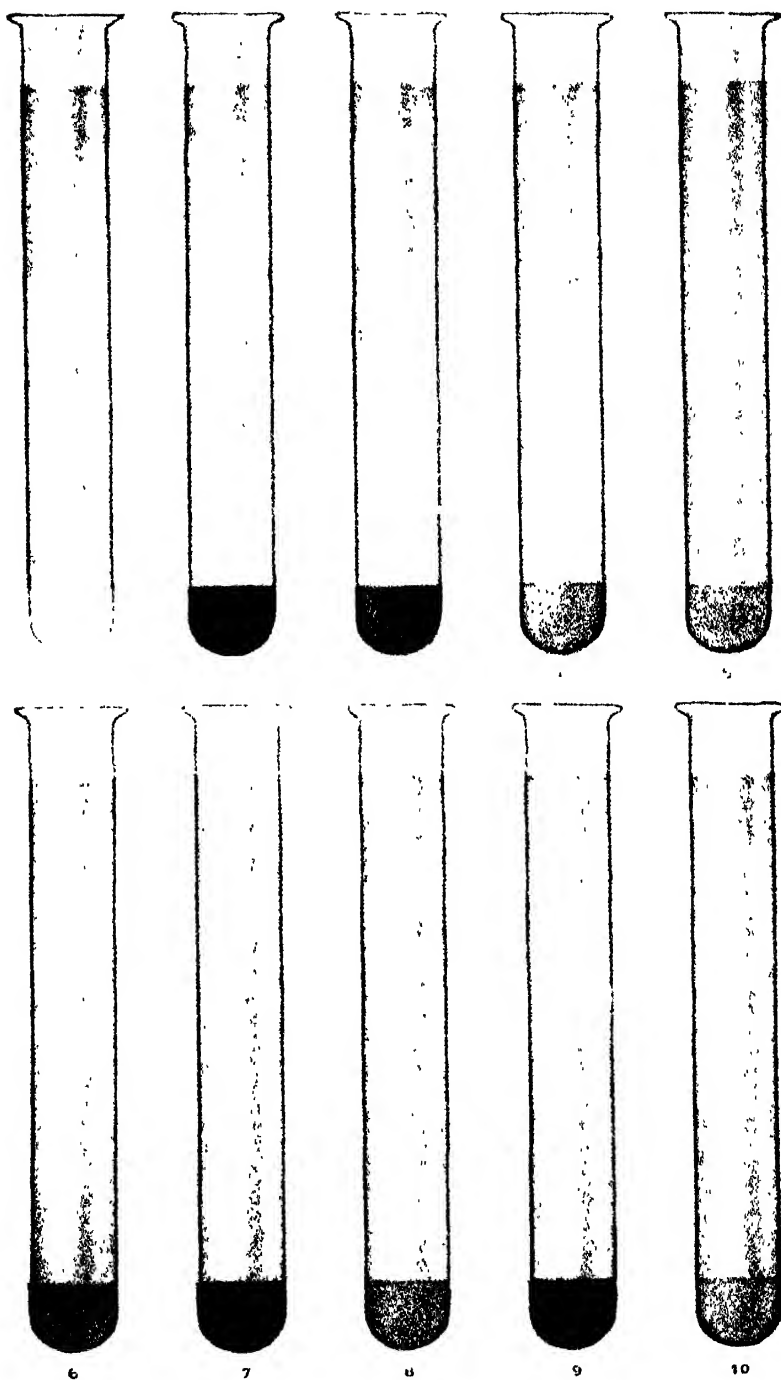
**Fig. 7.**—When the involvement of the liver is still greater the reaction will be still more green or it may assume deep green or bluish black. Where the putrefactive process and the liver involvement are both very pronounced, the deposited chloroform will be almost black.

**Fig. 8.**—When iodides are being taken by the patient and there is no putrefactive fermentation, the deposited chloroform instead of being white, as under normal circumstances, is cherry red.

**Fig. 9.**—If in conjunction with the use of the iodides by the patient, there is also pronounced putrefactive action, the deposited chloroform will be decidedly violet.

**Fig. 10.**—If the putrefactive process is less intense, the deposited chloroform will assume a more pink color.

The shade of color in the last two reactions, as in all the other tests, is governed largely by the amount and variety of the extraneous pigments added to the indigo.



Indican color scale. (H. H. Porter.)  
Post-Graduate.





latter cases—about 1½ per cent. of all—indicanuria and many of the clinical symptoms can be removed by high colonic lavage. 3. Recurrent, due to some recurrent anatomical lesion of the gastrointestinal tract. High colonic lavage will remove this type of indicanuria only when the lesion is located in the colon; if the lesion be higher up, however, high colonic lavage will have no influence whatever. Indicanuria in these cases is quite often the only positive evidence of gastrointestinal lesions which require surgical interference (chronic appendicitis, cholecystitis, ulcer of the duodenum or stomach). G. Baar (Northwest Medicine, July, 1913).

Indican has been recognized as a symptom of tuberculosis.

It must, nevertheless, be borne in mind that ingestion of large quantities of nitrogenous food is apt to lead to indicanuria even if no derangement of the digestion be present.

On account of the difficulty of obtaining the total 24 hours' urine of infants the writer had to be content with specimens collected at different hours. There is probably not as much difference between the day and night urine of infants as later in life. Of the 18 infants whose urine was systematically examined, 12 were less than a year and the oldest was only 17 months old. The children fed on cow's milk had a much larger indican and ethereal sulphates content than the breast fed, and the dyspeptic children had much more than the healthy children. The maximum was found in the children of the alimentary decomposition type, and those with grave digestive disturbances. Not a trace of either indican or ethereal sulphates was found in the healthy breast fed infants. L. Maccone (Rivista di Clin. Pediat., Jan., 1919).

In different diseases of the nervous system, especially after epileptic fits, an abnormal quantity of indican has been noticed in the urine.

In chronic cystitis indican may be de-

composed in the bladder and indigo deposited from the urine as a blue powder.

**TREATMENT.**—According to Eason, it is essential in most cases to restrict the amount of proteid, the rigor with which this is to be observed depending on the severity of the condition. The rules for mastication as formulated by Horace Fletcher are also of much importance. Hygienic and proper exercise in the open air is of great importance in aiding metabolism, increasing elimination and strengthening the digestive functions.

Patients fail to do as well as expected when treated medicinally. It is hardly advisable to use drugs for protracted periods, as the usefulness of the protective members of the intestinal flora may be harmfully influenced.

Lavage of the colon and stomach may sometimes prove necessary.

Sour milk is an important remedy in this connection. Rovighi drank daily a liter and a half (3 pints) of milk subjected to lactic acid alcoholic fermentation. In a few days the products of intestinal putrefaction in his urine were greatly reduced. Herter reduced the amount of indican in dogs by injecting pure cultures of lactic acid bacilli into the small intestines. These and other observations explain why sour milk is of such value as a medicine, and why lactic acid will control certain cases of infantile diarrhea. Mackee holds that sour milk will control the majority of cases of indicanuria.

Metchnikoff believed that sour milk was of benefit not alone in virtue of its lactic acid, but also on account of the large number of desirable bacteria contained therein, which are able to colonize in the intestines, but Herter's work tended to disprove this view. Mackee found that although lactic acid will control indicanuria to some extent the indican will return to its original degree very soon after the lactic acid is discontinued. Buttermilk and milk soured by native bacteria have more thorough and more enduring favorable effects. Even better results are obtained if milk be fermented by certain foreign bacteria. When employing such preparations as the lactobacillin tablets, the lactone, or yoghurt capsules, it should be remembered that we are only giving

relatively small numbers of bacteria, and they must be given over an extended period of time and combined with a favorable diet before their effects become clearly manifest. Pure cultures are especially convenient for those individuals who cannot tolerate sour milk, but the results are not so striking.

The ordinary antiseptics are useless. Large doses, or frequently repeated small doses, of calomel for the inhibition of the action of the pathogenic micro-organisms in the alimentary tract, also tannalbin, balsam copaiba, and aspirin have been recommended. The tannalbin acts largely by precipitating the thick, tenacious mucus so abundant in the alimentary tract. The balsam and aspirin are given in *fel bovis inspissatum* and pancreatic extract and the use of 1 per cent. ichthyol irrigations carried high up in the colon are said to have given good results. L. and S.

**INDICANEMIA.**—According to Tchertkoff (*Revue Méd. de la Suisse Romande*, Aug., 1917) indican in the blood is a sign of grave incompetency on the part of the kidneys. The technique he describes for estimation of the indicanemia reveals it only when it is within a pathologic range: to 8 or 10 c.c. of serum (obtained fasting by wet cupping or puncture of a vein), he adds an equal quantity of 20 per cent. trichloroacetic acid, and filters. Then, to 10 c.c. of the filtrate he adds an equal quantity of concentrated hydrochloric acid containing 5 mg. of ferric chloride to the liter. The whole is agitated, and then 3 c.c. of chloroform is added. After having agitated it several times in the course of fifteen minutes, he examines for the color reaction. The chloroform changes to a light or dark blue according to the proportion of indican in the serum. If there is no indican, the chloroform has no color. If there is iodine in the serum, the chloroform turns pink or a pinkish violet. This technique is reliable also for detection of iodine in the serum, but as this may interfere with the indican reaction, no iodine should be given the patient before the test. In his examination of 300 serums, indicanemia was invariably found when the azotemia reached nearly 1.5 Gm. to the liter, but it sometimes disappeared before

the latter—a favorable sign. It persists to the end in the fatal cases. Experimental research confirmed these clinical findings. There may be indicanemia with slight uremia, but the prognosis should be based on the persistence of the former. He thinks there is no need for quantitative estimation of the indican; the fact that it is within pathologic range is enough. The range shown by the technique described is about 2.5 mg. Any amounts above this show merely that the production of indican is large; they reveal nothing beyond the fact of renal incompetency already shown by the 2.5 mg.

In a study of the retention of indican in the tissues, Becher (*Deut. Archiv f. klin. Med.*, Apr. 29, 1919) finds that, contrary to nitrogen retention, no indican is found in the tissues when the kidneys functionate physiologically. When, however, incapacity of the kidney occurs, retention of indican is evident. He found the larger proportion in the blood, and but very small amounts in the tissues. In cases of severe renal insufficiency, acute glomerulonephritis and diabetic coma, Klein (*Med. Klin.*, May 29, 1925) observed a lack of correspondence between the low indicanemia present and the high residual nitrogen. In these various cases the discrepancy may be explained, he believes, on the basis of disturbed cleavage of proteins.

**INFANT FEEDING AND NURSING.** See NURSING AND ARTIFICIAL FEEDING.

**INFANTILE PARALYSIS.** See SPINAL CORD, DISEASES OF.

**INFANTILE SCORBUTUS.**—**DEFINITION.**—A constitutional nutritional disease identical with scurvy of adult life, but occurring chiefly in infancy. Its principal features are pain on movement of the limbs, swelling in the course of the long bones, and a spongy, purple swelling of the gums.

The classic picture of Barlow's disease is uncommon. The initial signs are generally limited to a few petechial

hemorrhages, erythrocytes in the urinary sediment, and probably slight swelling of the bones. H. Aron (Berl. klin. Woch., Oct 7, 1922).

Although scurvy is often associated with rickets, there is no necessary connection between them. Many of the older cases were described under the title of "acute rickets."

**SYMPTOMS.**—Anemia, irritability, and loss of appetite may occur as premonitory symptoms, but the first characteristic manifestation is pain in the limbs, usually the lower extremities. This may develop so suddenly that the parents are disposed to attribute it to an accident of some kind. The pain and tenderness on passive movement are at first intermittent, but soon become more constant, and the child holds the legs as though they were paralyzed, and screams on the slightest movement of them. The condition, in fact, amounts to a pseudoparalysis. In other instances the pain is limited to the arms.

Subacute and latent forms of infantile scurvy are very common among artificially fed infants in the larger cities where the whole milk supply is pasteurized. In latent scurvy the diagnosis rests largely upon prompt gain in weight and general improvement following addition of orange juice to the diet. To prevent these forms of scurvy in babies fed mainly upon pasteurized milk, orange juice, should be begun when the infant is a month old with a dose of a teaspoonful daily, to be increased so that at three months a tablespoonful is taken. A. F. Hess (Jour. Amer. Med. Assoc., Jan. 27, 1917).

An infant was given a boiled milk mixture, then a decoction of Nestlé's flour to the age of 7 months. The left ankle became tender and the leg swollen. Osteomyelitis of the tibia was diagnosed. The gums were swollen and cyanosed. Incision in

the back of the leg showed a large blood-filled cavity extending down to the bare tibia. There were skin hemorrhages in 2 places. There was irregular fever for 2 weeks. Under fresh milk and lemon juice recovery took place. L. Nicolaysen (Norsk Mag. f. Laegevid., Sept., 1924).

At about the same time, or a little later, there develops a deep bluish-purple, spongy swelling of the mucous membrane of the gums, generally over the upper incisor teeth. This may be so marked that the teeth become concealed. In most cases the involvement of the gums occurs only in infants whose incisor teeth have already erupted, but this is not necessarily the case.

Out of 72 cases, 90 per cent. had been erroneously diagnosed. Hemorrhagic gingivitis was absent in 22 per cent., but the children always cried when moved, the bones evidently being tender. Comby (Bull. Soc. méd. des hôp. de Paris, Feb. 25, 1921).

The scorbutic child often has punctiform or patchy hemorrhages on the face, particularly the orbital region. Fever is frequently present. Hemorrhages from the gums are seen mostly on the inner side. The ribs often simulate the "rosary" characteristic of rickets, but the condition is readily distinguished in that they are painful and tender and that the edges are corrugated or toothed instead of rounded. The right heart is invariably dilated, and this can usually be made out clinically.

In at least  $\frac{1}{2}$  the cases of infantile scurvy subdermal hemorrhages may be observed 3 or 4 months before the characteristic scorbutic manifestations develop. H. L. Ratnoff (Arch. of Ped., Mar., 1925).

Together with the painfulness of the limbs, swelling in the shaft of the long bones can often be found. It is usually near a joint, but does not involve it. The soft tissues in the

affected situation are swollen, shining, but usually not reddened. Not infrequently, however, ecchymoses or petechiæ are found here or elsewhere. Orbital hemorrhage occurs in a small proportion of cases, producing a very characteristic exophthalmos. Hemorrhage from the kidneys is a common symptom, although usually of a nature discoverable only on microscopic examination.

Case in which there was extensive edema; no part of the body seemed exempt. The infant, aged 9 months, had a pallid, waxy appearance; although it looked as if the skin would easily pit on pressure, it was practically impossible to obtain a permanent indentation with the fingers. Pritchard (*Lancet*, June 7, 1913).

The general condition of the child suffers, and anemia is progressive, accompanied by wasting. There is a cachectic appearance, and one expressive of constant pain.

In a personal case the blood-picture showed hemoglobin, 40 per cent.; erythrocytes, 800,000; leucocytes, 12,000; polymorphonuclear cells, 40 per cent.; lymphocytes, 60 per cent.; eosinophiles, 1 per cent. Many megaloblasts, normoblasts, and transitional forms were found. In four weeks, under antiscorbutic treatment, the blood-picture was almost normal, the cartilage changes almost gone and the child fairly recovered. F. Glasier (*Berl. klin. Woch.*, i, 200, 1913).

The writer comments on the increasing frequency with which Barlow's disease is being encountered, on account of the widespread use of prepared foods, fresh milk having become too expensive for the poorer classes. In 1 of the author's recent cases, a 4 months' child was being given but 8 ounces of milk a day. It lost weight, became very pale, and suddenly grew extremely feeble, lying motionless with the legs partly flexed,

and very sensitive to movement. The left thigh was somewhat larger than the right. Complete recovery occurred under increased feeding and orange juice,  $\frac{1}{2}$  ounce 4 times a day. The fact should be borne in mind that there are often encountered "fruste" forms of the disease, without bony or epiphyseal deformities or swelling of the gums. Thus, in 1 case there was noted weakness, apparent anemia, marked feebleness of the legs simulating paralysis, neuritis or acute poliomyelitis, and pain upon the least movement, suggesting arthritis and, in particular, joint tuberculosis. In another fruste case, the symptoms comprised merely swelling, softening, ulceration, and bleeding from the gums. Errors of diagnosis have been frequent in relation to this disease. Albert Jobin (*Bull. méd. de Québec*, Apr., 1919).

**COMPLICATIONS.**—Rickets is the most frequent of these, present in certainly over 50 per cent. of cases. Bronchopneumonia and gastroenteritis are not uncommon complications.

**DIAGNOSIS.**—Although the disease is usually easily recognized, many errors are made, because the possibility of scurvy does not occur to the physician. The diagnosis rests upon the great pain and tenderness of the limbs, and the tendency to hemorrhage into the skin and the gums. The disease is often mistaken for rheumatism. This affection, however, is of extreme rarity in infancy, and exhibits swelling of the joints rather than of the shafts of the bones. The epiphysitis of syphilis suggests scurvy in some instances. It, however, occurs generally at an earlier age, is less tender on movement, and is oftener limited to the arms. The lesion, too, is always situated at the epiphysial junction, and not in the shaft of the bone. The pseudoparal-

ysis of scurvy bears some resemblance to poliomyelitis. There is, however, in the latter disease far more tenderness combined with an alteration of the electric reactions. Osteomyelitis invades the joints and is attended by fever and symptoms of pyemia. The frequent complication of scurvy by rachitis is often the cause of the overlooking of the former disease. In rickets, however, there is no hemorrhagic tendency, and improvement under treatment is slow.

The anemia commonly observed in infantile scurvy is not secondary but due to the same cause as the scurvy. A typical scurvy anemia is as follows: Red cells, 2,600,000; hemoglobin, 35 per cent.; color index, 0.67; leukocytes, 13,600; neutrophils, 30.2 per cent.; eosinophils, 4.2 per cent.; mononuclears, 8.7 per cent.; transitionals, 2.1 per cent.; lymphocytes, 54.8 per cent.; a few megaloblasts and normoblasts; poikilocytosis; anisocytosis; polychromatophilia; a few basophilic erythrocytes. C. Gottschalk (*Arch. f. Kinderhik.*, Dec. 18, 1923).

Conditions for which infantile scurvy has been mistaken comprise rheumatism, trauma, infantile paralysis, osteomyelitis, sarcoma, syphilitic epiphysitis, hemorrhagic nephritis, intussusception, rickets, nasal diphtheria and spondylitis. J. Sobel (*Amer. Jour. of Surg.*, Feb., 1925).

**ETIOLOGY.**—Nearly all the cases occur in the first two years of life, and the majority of these in the latter half of the first year. There is a distinct tendency to greater prevalence in some countries than in others, which cannot be attributed to greater fault in the method of feeding the infants.

The writer observed 45 cases of scurvy in infants at Paris. None of them had been getting breast milk or fresh milk or even simply boiled milk; all had been fed with sterilized flour

foods. Signs of rachitis were present in nearly every case. The artificial feeding is responsible for both. If the milk is sterilized—dead milk—there may be both scurvy and rachitis; if the food is fresh—living milk—the child is exposed to danger of rachitis alone. J. Comby (*Arch. de Méd. des Enfants*, July, 1917).

The principal cause of infantile scurvy has been demonstrated to lie in a deficient intake of the antiscorbutic vitamine—vitamine C. It occurs mainly in artificially fed infants, especially those receiving proprietary foods subjected to prolonged or excessive heating. Reheating of milk may be a factor in destruction of the necessary vitamine, and according to A. F. Hess, pasteurized milk is more likely to bring on scurvy than milk heated to boiling for a few minutes. In general, however, scurvy is much less frequent when milk is the principal food taken. It is possible, but rare, for it to occur in a breast-fed infant; improper diet and poor health of the mother are predisposing factors in such cases.

Good general hygiene and favorable social conditions rather predispose to the disease than the reverse, because they are more likely to be associated with artificial feeding and unusual precautions in sterilization of the infant's food.

Milk contains but little of the water-soluble antiscorbutic vitamine. More than half the cases of infantile scorbutus are due to milk that has been fixed or rendered homogeneous, whether sugar is used or not. Milk boiled for 10 minutes or pasteurized by a single heating at 60° to 80° C. did not produce scorbutus in guinea-pigs, but the vitamins were destroyed by a second heating. Milk powders are capable of producing infantile scurvy, and do not cure the condition.

Lesné and Vaglianos (Nourrisson, Nov., 1922).

Vitamine C is the most sensitive of all vitamins to the action of oxygen, heat and cold. All substances containing vitamine C, even lemon prepared in a vacuum, lose it on standing. Marfan declared that all condensed milk cans should be dated, and Rousseau's research indicates that no such milks should be used for infant feeding if prepared longer than a fortnight. E. Rousseau (Nourrisson, July, 1923).

The catalytic action of even minute doses of copper suffices for the destruction of vitamin C in milk. Copper equipment for the pasteurization of milk, if not in good repair or well cared for, deprives the milk of its vitamin C. This applies also to the preparation of condensed milk. A. F. Hess and M. Weinstock (Jour. Amer. Med. Assoc., Mar. 22, 1924).

Aside from improper feeding it would appear that there exists some individual predisposition, otherwise all children receiving sterilized foods would suffer from the disease.

It is noteworthy in this connection, however, that even with a diet decidedly insufficient in vitamine C, considerable time elapses before the clinical manifestations of the disease appear.

Case of scurvy in a 9 month infant fed with fresh cow's milk that had been subjected only to a single 10-minute heating. This illustrates the probability of a special predisposition to scurvy in certain infants. Lemaire (Bull. Soc. de p  d. de Paris, Oct. 17, 1922).

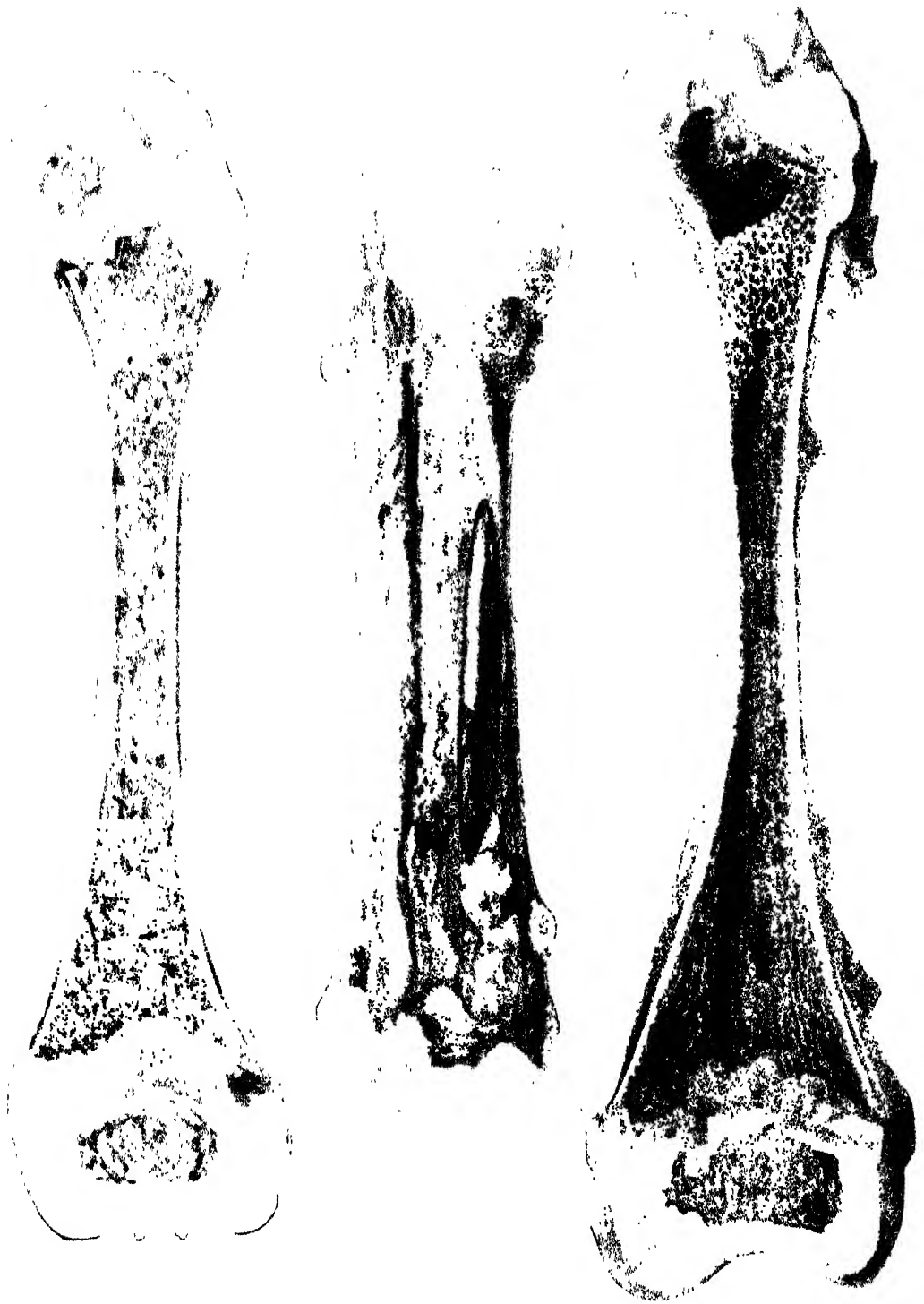
Having observed infantile scurvy in 1 of 2 twins fed in the same way and on identical foods, the writer concluded that deficiency of vitamine C could not be the only pathogenic factor and that dyspeptic malassimilation was a concomitant factor in the scorbutic twin. Wallgren (Acta Ped., May 31, 1923).

A scorbutic diathesis exists, demonstrable by the appearance of petechiae in the capillary resistance test [applying a tourniquet to the upper arm, inducing petechiae on the forearm]. When this diathesis exists, the proper stimulus, toxic or mechanical, is able to produce active scurvy. An infection, however slight, is almost certain to bring on the symptoms or cause recurrence. H. L. Ratnoff (Arch. of Ped., Mar., 1925).

#### **PATHOLOGICAL ANATOMY.—**

The principal lesions are those of the bones, combined with a tendency to hemorrhage in various other regions. The bone-marrow is replaced by embryonic connective tissue. There is an arrest also in the formation of bone from the osteoblasts. The X-ray may show diminished density of the subepiphyseal region, and just above this, at the epi-diaphyseal junction, a transverse, irregular zone of increased density, appearing in the negative as the "white line of Fraenkel." Hemorrhage is found beneath the periosteum (appearing in the radiogram as spindle-shaped shadows), and also frequently elsewhere as well, as into the muscles and skin, the serous or mucous membranes, or in the internal organs.

Successive roentgenograms of the bones in severe infantile scurvy are very characteristic. The ends of the metaphyses terminate in shadow bands usually of frayed structure and often projecting transversally. While normal ossification may be seen extending over these necrotic areas as early as 2 or 3 weeks after clinical recovery, traces of the reticulated transverse bands may persist for 3 or more years. In severe cases the center of the epiphysis retains the appearance of a thick shell with a sharply circumscribed, light-colored nucleus. H. Winberger (Fort. a. d. Geb. d. R  ntg., June 17, 1924).



Bone lesions in infantile scorbutus.





## INFLUENZA, OR LA GRIPPE (SAJOU)

**PROGNOSIS.**—The disease runs a chronic course with little tendency to improvement, and death is liable to occur in severe cases unless treatment is instituted. Under appropriate treatment, however, recovery is remarkably rapid.

**TREATMENT.**—The abandonment of proprietary food, and sometimes the changing from a cooked milk mixture to one of raw milk should be done unless there is a contraindication. Sometimes, for other reasons a change in diet is not advisable.

The specific treatment for the disease is the administration of fresh fruit-juices. Of these orange-juice is one of the best, the juice of half an orange, and later of a whole orange, being given daily. The presence of diarrhea is no contraindication.

Lemon juice is likewise effective, but less easily accepted by infants. One to four ounces (30 to 120 c.c.) daily of strained canned tomato protects an infant from scurvy (Hess).

The administration of fruit-juices is as prompt in its effect as quinine in malaria. Orange-juice is the best of the fruit-juices and can be given in doses of 1 tablespoonful or more every two hours. Grape-juice comes next in value while lemon-juice is held too acid. Comby, Still, and others give mashed potatoes or potato soup besides the orange-juice, while Baginsky had good results from fresh brewers' yeast. Wright has advised the giving of sodium lactate.

Rest is essential, with a minimum of handling. Orange-juice should be given to all infants coming under the physician's care after having been upon any of the proprietary foods, or condensed or sterilized milk, for any length of time. Such infants ought also to be placed upon an uncooked milk mixture at once. M. Ostheimer (N. Y. Med. Jour., June 25, 1910).

Case of a boy of 6 who refused all food except boiled milk and rolls. After a year of this, he developed infantile scorbutus in a very severe form. Rapid recovery occurred on raw milk and lemon-juice. Glaser (Berl. klin. Woch., Feb. 3, 1913).

Administration of vegetables and raw milk, which are rich in vitamin C, gives good results in many cases. The diseased condition of the mucous membranes is best treated with a 1 per cent copper sulphate solution. Schagan (Jahrb. f. Kind., Feb., 1924).

The prophylactic treatment of infantile scurvy consists in the taking of measures to insure an adequate amount of antiscorbutic vitamin in the food of bottle-fed infants. If any hemorrhagic manifestations appear and hemophilia and purpura can be excluded, addition of orange-juice, lemon-juice or tomato-juice, 2 to 4 tablespoonfuls daily, to the feedings is urgently indicated.—Ed.

For children over a year, potato or other fresh vegetables may be given with advantage. For the later treatment of anemia and debility, iron and codliver oil may be employed.

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## INFLUENZA, OR LA GRIPPE.

**— DEFINITION.**—An infectious, contagious disease, characterized by acute inflammation of the upper respiratory tract and bronchi, a sharp constitutional reaction, marked prostration, and more or less frequent secondary involvement of the lungs, digestive tract, or nervous system.

**SYMPTOMS.**—The incubation period of influenza is at times very short—but a few hours, according to some,—while in other instances it appears to extend to four days, or more. Two days may probably be considered the average incubation period. The onset is often conspicuously sudden, a person going to bed apparently

well and waking up with headache and malaise, or even experiencing sudden dizziness and weakness while at work. Chilliness and malaise are the commonest initial symptoms, though headache and unwonted body heat are sometimes those first noticed. More or less marked rigors may occur. According to Dubé, the best way to detect early an oncoming influenza during an epidemic is to take the temperature at regular intervals in the as yet apparently healthy subject.

Other typical early symptoms are pains in the back and limbs, ranging from mild to very severe; marked weakness; slight, dry cough, and frequently reddening of the fauces and obstruction to nasal breathing. Thirst is apt to be augmented and the appetite is reduced. By the second day the patient is, as a rule, distinctly worse. Congestion of mucous membranes, including the conjunctivæ and sometimes the gums and tongue, is more marked; photophobia may exist; the tongue may be coated; backache may be severe, and the bowels are usually constipated. Somnolence often exists, and prostration is marked. The expectoration is scanty and tenacious at first, later more copious, purulent, and often streaked with blood.

The temperature rises by the second day to 100° F. (37.8° C.) up to 104° F., (40° C.) according to the severity of the case. In the more marked cases it may have reached 103° F. (39.4° C.) on the first day. In many instances the condition is a "three-day fever," the temperature beginning to recede after the third day; in a considerable proportion, however, temperatures up to 104° F. (40° C.) or even slightly higher are reached for 4, 5, or 6 days, after which a descent to subnormal by

more or less rapid lysis is the rule. In general the curve is less regular than in typhoid fever, resembling the latter in that the evening temperature is the highest in the day. Some cases show 2 peaks in the temperature curve.

The pulse is sometimes relatively slow—76 to 110—in comparison with the temperature. Usually it is feeble, and it may be irregular or intermittent. Sweating is easily provoked, and various signs indicating a relaxed circulation exist. Not infrequently a dangerous extent of depression of the heart is produced. Dyspnea and cyanosis may occur in the absence of lung complications.

The nervous system appears to be very susceptible to the influenza toxin, and according to some, is the prime sufferer in this disease. The sudden and violent prostration may perhaps, be looked upon as an evidence of central nervous intoxication, as may also the severe, sometimes lancinating, pains in the limbs and back and the frontal and postorbital headache. In a minority of cases, pain may be experienced in the bones, chest, lumbar region, or testicle, or may simulate pleurisy, pericarditis, stone in the kidney or bladder, or hepatic or intestinal colic (Harris). Usually these pains are much improved after two or three days.

Delirium and sleeplessness, more or less pronounced, are not infrequent at the height of the disease. In some cases, however, especially among young children, persistent somnolence or a semi-comatose state is observed.

Not a few cases of influenza develop skin rashes. These may be diffuse or localized, and uniform or morbilliform. Their extent seems to bear no relation-

ship to the severity of the case, and as a rule they are readily distinguished from the eruptions of scarlet fever or measles by their situation and duration. Occasionally herpes about the lips is noticed.

The catarrhal symptoms vary considerably in different cases. In some patients there are repeated fits of sneezing, with pronounced coryza and lachrymation. The conjunctivæ are likely to be congested and painful; they may, however, be relatively dry and itchy (N. S. Davis). Certain cases are suggestive of hay fever or bronchial asthma. Precordial oppression may be such as to suggest angina pectoris. Initial or early epistaxis was a rather conspicuous feature in the 1918 pandemic. It is sometimes followed by acute catarrhal rhinitis with profuse muco-purulent discharge and orbital pain. The nasopharynx may undergo diffuse inflammation or there may be lacunar tonsillitis. The larynx may be the seat of acute catarrhal inflammation, with hoarseness and dysphagia. Cough is paroxysmal, distressing, and persistent (Thomson).

The usual absence of leucocytosis in influenza is of service in differentiation of the disease from many other acute infections, in which a definite leucocytosis occurs. The white cell count in uncomplicated influenza ranges between 5000 and 8000. Forbes and Snyder found it lowest on the second day of the disease and believe a relative lymphocytosis also characteristic of this affection. Synnott and Clark observed a case with only 1200 leucocytes. Erskine and Knight report a marked prolongation of the coagulation time of the blood in every case tested.

Convalescence from influenza is, as a rule, discouragingly slow, most patients

not being restored to approximately normal strength for several weeks after defervescence. Meanwhile, the patient lacks ambition and endurance, may appear neurasthenic, and in a few instances develops melancholia or hysterical phenomena. Occasionally, normal feelings and zest do not return for a number of months. During early convalescence rises of temperature readily occur upon slight exertion. A hacking cough and abnormal expectoration may persist for some time after recovery. Sequelæ in the form of lasting weakness of the circulation or disturbances of the respiratory tract not infrequently occur.

**Clinical Types.**—Marked variations in the symptoms of influenza render possible the recognition, not only of several different types or case groups showing certain combinations of symptoms, but also of certain forms seemingly unrelated to the disease. The following groups of uncomplicated influenza cases are recognized by W. L. Somerset: (1) Fever with accompanying chills, malaise, and headache, but no other symptoms; though usually mild and brief, these cases may continue febrile for 2 or 3 weeks. (2) Fever with pain in the limbs, back, and thorax. (3) Fever with physical and mental prostration. (4) Fever with catarrhal inflammation of eyes, nose, pharynx, tonsils, or larynx (usually the largest case group). (5) Fever with bronchitis, which may or may not be accompanied by the conditions in the preceding group.

More widely divergent groups of cases are as follows:

**Gastrointestinal Type.**—In this variety the catarrhal symptoms are centered in the digestive tract. There is early vomiting, which is likely to be

repeated. Often there are also abdominal pain and diarrhea. These symptoms show marked persistence, and resist treatment. The diarrhea may be serous, suggesting cholera, or bloody stools may be passed.

*Nervous Type.*—This may be said to exist where the nervous symptoms such as delirium or semicoma, are particularly striking. It is sometimes identified with the *typhoid type*, symptoms of the typhoid state being apparent. Neck rigidity, convulsive seizures, local paralyses, and hemiplegia, while nervous phenomena, are more properly considered under the head of Complications.

*Cardiac Type.*—This is characterized by symptoms of heart-failure, rapid, feeble, irregular pulse, dyspnea, cyanosis, and paroxysmal tachycardia.

*Fulminating Type.*—After a sudden onset associated with marked dyspnea, the patient becomes cyanosed, the pulse uncountable, and death occurs in from 24 to 48 hours.

*Ambulatory cases* of influenza occur, the chief danger of which is that they assist markedly in the propagation of the disease. Accurate differentiation of the mild cases of true influenza from ordinary acute catarrhal disorders is difficult, particularly in view of our present lack of definite knowledge of the cause of influenza.

*Influenza in Infancy and Childhood.*—The symptoms in these cases are much the same as in adults. In the usual, respiratory type the nasopharynx is prominently involved, and pulmonary complications sometimes follow. Peevishness and restlessness at night are noted, and cough may be present. In the gastric or gastroenteric form, when occurring in infants, the clinical picture resembles that of the

midsummer type of cholera infantum, anorexia, vomiting, and diarrhea suddenly making their appearance. Pronounced fever and flushing, and a high pulse and respiratory rate are noted, even in the absence of lung involvement. Apathy, meteorism, flatulence, a coated tongue, hyperemic fauces, and sometimes an odor of acetone are usual accompaniments. The acid, foul-smelling stools may cause inflammation about the arms and over the buttocks (Fischer). Müller has described an infantile septic form in which high fever alternates with subnormal temperature; in a few instances this condition proves rapidly fatal or recurs at more or less protracted intervals.

*Influenza in Pregnancy.*—When severe and associated with lung complications, influenza is an extremely serious affection and is associated with abortion or premature labor in a large percentage of cases, frequently followed by death of both mother and child (Bland).

**COMPLICATIONS AND SEQUELAE.**—*Respiratory Tract.*—*Pneumonia.*—Lung complications are chiefly responsible for the high mortality from influenza. The pulmonary involvement is oftener lobular than lobar. N. F. Friedman, in X-ray studies during the 1918 epidemic, observed, in early cases, marked peribronchial infiltration with a local or general mediastinitis. The condition then either became stationary, the patient showing clinical improvement, or the process rapidly extended into the lung structure with the development, as a rule, of a bronchopneumonia, usually bilateral, sometimes unilateral. In a few instances the pneumonia was lobar, being confined to one or more lobes; the right lower lobe was usually

that first involved. In these cases the movements of the diaphragm on one or both sides were impaired while in bronchopneumonia they were unaffected unless the infection was very extensive. Frequently the heart was distinctly bottled-shaped, owing to degeneration of the heart muscle with dilatation. A great similarity of the findings in the bronchopneumonias to those of acute pulmonary tuberculosis was noted.

Clinically, secondary pneumonia may be suspected where, in addition to fever, rapid pulse, and prostration, there is an increased respiratory rate, cough, and bloody sputum. Not infrequently no physical signs of pneumonia are elicited at the first examination. When apparent, they vary from impaired resonance, particularly over the lower lobes, with diminution of vesicular murmur and showers of crepitant or later subcrepitant rales, to more definite indications such as dullness, bronchial breathing and voice sounds, and increased fremitus and whisper. At first these signs may be confined to a small area, *e.g.*, in the upper portion of the right lower lobe or high up in either axilla. Physical signs of lobar pneumonia are sometimes elicited where the actual condition, as shown by the X-ray or autopsy, is a bronchopneumonia.

According to M. J. Synnott and Elbert Clark, disparity between the temperature and pulse rate, *e.g.*, a temperature between 104° F. (40° C.) and 106° F. (41.1° C.) coexisting with a pulse rate below 100 or even below 80, is a marked aid in the differentiation of influenzal pneumonias from those of purely pneumococcal origin. Stress is also to be laid on the early, marked, and progressive cyanosis, frequently

apparent before there are any demonstrable physical signs of pneumonia; the mental condition of either marked apathy or delirium; the marked prostration; the rapid progression of the pneumonia; the infrequency of herpes labialis; the variability in the characteristics of the sputum—mucoid, mucopurulent, blood-streaked, frothy, bloody, or thin “prune juice;”—the free, often painless, sometimes paroxysmal cough, and the tendency to relapse. Hector Mackenzie reports having seen several cases in which the physical signs of consolidation persisted for several months after influenzal pneumonia, then gradually disappeared.

*Pulmonary Edema.*—General edema of the lungs, associated with pericardial effusion, frequently supervenes in cases already complicated with severe pneumonia. It constitutes a relatively frequent terminal condition.

*Empyema.*—In occasional instances empyema follows the lung infection. Friedman, in his X-ray studies, noted empyema at times in the lobar type of secondary pneumonia, while in the lobular type multiple abscess formation took place. These relationships do not, however, always hold good, empyema sometimes following a bronchopneumonia.

*Pulmonary Tuberculosis.*—Acute lung involvement secondary to influenza is stated sometimes to pass into active tuberculosis. Some cases are left with localized bronchitis which, if in the upper lobe, is difficult to distinguish from tuberculosis; others develop bronchiectasis or lung abscess; sputum examination and a leukocytosis with polynucleosis aid in excluding tuberculosis (Fishberg).

Reference to a condition styled *post-influenzal chronic pneumonitis*, these pa-

tients still presenting themselves for treatment with a history of continuous pulmonary disease since the last pandemic. They are tired and weak, and have cough, slight or severe, and shortness of breath and palpitation on slight exertion. Examination of the lungs yields a variety of findings, and the changes are rarely, if ever, confined to the apexes. There seems to be no great change in the condition from year to year. The common statement that influenza predisposes to tuberculosis may be due to confusion with this state. McCrudden (*Jour. Amer. Med. Assoc.*, Mar. 3, 1923).

**Nervous System.**—No acute disease has such varied nervous sequelæ as influenza. In the cerebrum the poison often causes a temporary intoxication unattended with permanent damage, but it may also cause intense and fatal congestion, with minute meningeal hemorrhages, meningitis, or finally acute hemorrhagic encephalitis. In some instances the complicating meningitis is of streptococcal or pneumococcal origin. Intense headache or neuralgias, restlessness or delirium, convulsions, paralyzes, stupor, and unconsciousness are the main clinical features in these cases.

Encephalitic features have been noticeable in some of the late epidemics. Moncalvi, among others, observed in Milan, neuro-encephalitic forms of the disease, several cases closely resembling epidemic encephalitis.

Various types of neuralgia often complicate the disease, usually appearing as defervescence is taking place. Neuritis, more or less severe and extensive, is very common. These conditions, however, seldom terminate fatally. Neuritis of the various cranial nerves, brachial neuritis, sciatic neuritis, multiple neuritis, etc., have all been

met with. Paresthesias of all sorts have been reported as sequelæ.

Spinal affections which may complicate influenza comprise herpes zoster, acute anterior poliomyelitis, acute myelitis—usually cervical and accompanied by meningitis,—ascending myelitis, and Landry's paralysis. Progressive bulbar palsy and myasthenia gravis have also been recorded.

In the psychic sphere, the manifestations vary from those of delirium, melancholia, or delusions, to hysteroid convulsions, catalepsy, and trancelike states.

Certain visceral symptoms occurring early in the course of influenza may be attributed to disturbance of nerve-supply by the infection, *e.g.*, the neurotic polyuria and watery diarrhea sometimes met with (Harris).

**Circulatory System.**—*Heart.*—The heart not infrequently becomes dilated as a result of influenzal intoxication. This is especially apt to occur in individuals past middle life, and in the obese and alcoholic (N. S. Davis). The condition often persists for weeks or months after the acute attack, the heart remaining irritable and its rate easily increased.

At the onset of influenza bradycardia and sudden syncopal attacks have been observed. Later, irregular rhythm and an extremely frequent beat (auricular fibrillation) are not infrequently met with. It is believed that myocarditis may be induced or accelerated by influenza. Eichhorst has reported a case in which intense tachycardia preceded other influenzal symptoms by one week.

*Vessels.*—Phlebitis, thrombosis, and embolism are occasional complications. Synnott and Clark observed gangrene of the foot from embolism in two cases. In the brain, thrombosis may

give rise to such manifestations as hemiplegia, motor aphasia, agraphia, and temporary blindness or hemianopsia. Sudden blindness has also resulted from embolism and thrombosis of the central artery of the retina.

Vascular relaxation due to the influenza toxin may be a favoring factor in the various forms of congestion and visceral hemorrhage observed by numerous authors.

**Blood.**—Synnott and Clark refer to several cases in which the infection produced a marked hemolytic effect, with rapidly progressive anemia. In one instance the red cells were reduced to 1,600,000 with 50 per cent. hemoglobin, by the fifth day of the disease.

**Kidneys.**—Acute nephritis secondary to influenza is relatively infrequent. Rather often, however, albumin and casts occur in the urine during the febrile period. Gotch and Whittingham, during the 1918 epidemic, even found albumin in 90 per cent. of all cases. Hyaline and granular casts were also found in 85 per cent. of cases of the five-day-fever type, and in 36 per cent. of cases of the three-day-fever type. The casts usually disappeared by the fifth or sixth day and the albumin by the eighth or ninth. Synnott and Clark observed retention of urine to be not uncommon. Influenza may also cause aggravation of a pre-existing renal disease, impaired renal function during protracted convalescence, or an actual postinfluenzal nephritis.

**Special Sense Organs.—Ears.**—Otitis is a common complication of influenza, and is characterized, on the whole, by rapid destruction of tissue, in spite of but slight suffering on the part of the patient, and by early mastoid involvement and extension to the meninges. Many cases of chronic otitis

media result (Davis). Thrombosis of the sigmoid sinus or of the jugular bulb have been met with. Ear complications were relatively infrequent in the 1918 epidemic.

**Accessory Sinuses.**—Aside from the more or less pronounced inflammation of the nasal passages, the accessory sinuses not infrequently become involved. Aching pains may result from a mere swelling of the lining of the frontal sinuses.

**Eyes.**—Eye complications are comparatively rare, but may be serious. They comprise conjunctivitis, inflammation of the lachrymal duct, herpes of the cornea or eyelids, iridochoroiditis, glaucoma, and nervous disorders of vision. Optic neuritis, with choked discs and retinitis, was not infrequent in the 1890 epidemic. Retrobulbar neuritis may seriously impair vision. Sudden blindness from embolism and thrombosis of the central artery of the retina has also been recorded. Various forms of ophthalmoplegia may be met with, *e.g.*, loss of accommodation or of the pupillary light reflex, ptosis, and paralysis of any of the extraocular muscles.

**Olfactory Organs.**—Permanent anosmia not infrequently results from influenzal involvement of these organs.

**Hemorrhagic Complications.**—Hemorrhage in influenza appears to be favored both by peripheral vascular relaxation and by reduced coagulability of the blood. In the 1918 epidemic epistaxis occurred very frequently, especially in children. Hemorrhage also took place into the bowel, stomach, bladder, skin (purpura and petechial hemorrhages), cerebrospinal fluid, and from the gums and ears. Erskine and Knight reported a case of sudden death during convalescence, apparently from



hemorrhage in the brain. Some pneumonia patients succumbed suddenly to asphyxiation due to active hemorrhage from the lungs.

**Miscellaneous.**—Jaundice, probably of infectious and not of obstructive origin—the stools not being acholic—was observed in many severe cases in the 1918 epidemic.

Subcutaneous emphysema in the neck, face, upper chest, and arm was observed by Synnott and Clark in 20 cases.

Among the rarer complications and sequelæ that have been reported are peritonitis, subphrenic abscess, rupture of the rectus muscles, pulmonary embolism following thrombophlebitis, thyroiditis, pneumothorax, gangrene or abscess of the lungs, serofibrinous pleurisy, suppurative pericarditis, anginal attacks, endocarditis, multiple arthritis, parotitis, persistent vertigo, and insomnia.

In some patients having the gastro-intestinal form of influenza there finally occurs pain, tenderness, and rigidity localized in the right lower quadrant, marked enough in some cases to have led to the diagnosis of acute appendicitis. This involvement of the appendix is only a part of the enteritis of influenza. Recovery will take place unless secondary infection of the appendix occurs, as shown by the development of leucocytosis. Two patients developed leucocytosis, respectively, of 14,000 and 18,000. Appendectomy was done in each case under gas and oxygen anesthesia. C. J. Rowan (Trans. Western Surg. Assoc.; Med. Rec., Feb. 18, 1919).

**DIAGNOSIS.**—Recognition of influenza while an epidemic prevails is, as a rule, not difficult. In atypical, mild, sporadic cases, however, a correct diagnosis is often, in the present state of our knowledge, impracticable, since

the identity of the microorganismal cause of the disease is still in doubt and no certain bacteriologic means of diagnosis is available. That true influenza exists in a sporadic case, rather than a mere, ordinary "cold" is, perhaps, most satisfactorily indicated by such peculiarities as abrupt onset, unusual degree of prostration, relatively high fever, postocular pain, flushed face and eyes, backache, and marked pain in the extremities. Absence of a history of exposure to cold might serve as a distinguishing feature, influenza coming on more or less independently of such influences. From the present views as to influenza etiology, even the finding of the bacillus of Pfeiffer in pure culture in the discharges is not a definite proof of the existence of influenza. Jex-Blake warns against mistaking the onset of pulmonary tuberculosis for influenza. Such a mistake occurred in no less than 112 out of 416 unselected cases of tuberculosis. The leucocytic count is sometimes useful in the diagnosis of influenza.

*Typhoid or paratyphoid fever* may be suggested by the symptoms in the gastro-intestinal form of influenza. The distinguishing features of the latter in this connection are the sudden onset, the possible existence of an epidemic at the time, absence of rose spots, of splenic enlargement and of the typical temperature curve, and the negative results of the Widal or paratyphoid agglutination reaction and of blood cultures.

*Cerebrospinal meningitis* is sometimes closely simulated by influenza, which may cause painful retraction of the neck, vomiting, and other manifestations of a meningeal reaction—often passing off suddenly, however, after a few days. Lumbar puncture may con-

stitute the best, and almost the only, means of early differentiation in such cases.

*Smallpox* in its early stages is distinguished by an obstinate resistance to measures prescribed for symptomatic relief. Later, the rash settles any doubt.

*Dengue* is distinguished from influenza by the constant occurrence of a skin rash, the characteristic remission in the fever after the third day, and the more persistent pains in the joints and muscles, with a tendency to arthritis.

**ETIOLOGY.**—Although influenza occurs at all ages, young adults are the most frequently affected. Children below one year of age are relatively seldom attacked, while in middle and especially late adult age, an increasing resistance to infection is shown, possibly through an immunity established by an attack in a former epidemic.

Careful observation leaves no doubt but that a certain degree of immunity results from influenzal infection. Each pandemic appears so to immunize a considerable part of the population that another cannot occur until a new susceptible generation has grown up. Sahli deems it entirely possible that even those who escape influenza during a pandemic may imperceptibly acquire a partial immunity against the infection.

In spite of certain opinions to the contrary, the occurrence of influenza epidemics is seemingly not related to definite atmospheric or climatic states. In a given locality an epidemic generally reaches its height and shows marked decline within four to six weeks, though the remainder of the decline may subsequently occupy a prolonged period. Fresh outbreaks of

the disease, sometimes more severe than the initial one, may occur after an interval of apparent complete freedom from the disease.

The so-called "influenza bacillus" was described independently by Pfeiffer and Cannon in 1892, and is often termed the Pfeiffer bacillus. Its etiologic relationship to influenza, however is by no means established. Pfeiffer himself saw cases of "grippe" in which the germ was surely absent (Scheller). Not only have Pfeiffer bacilli been recovered from as high as 35 per cent. of sputums from normal individuals, but the germ has been found in a variety of diseases unassociated with influenza, *e.g.*, measles, diphtheria complicated by purulent bronchitis, whooping-cough, scarlet fever, tuberculosis, etc. When pathogenic, the Pfeiffer bacillus seems to be associated, most typically, with purulent inflammation of the bronchi and bronchioles (Kinsella).

Nevertheless, the Pfeiffer organism may occur in great numbers, and sometimes almost alone, in the mucopurulent flakes and clumps from the inflamed mucous membranes. The bacilli are very small rods, with rounded ends and staining most deeply at the ends. They grow best on agar which has been smeared with blood and form minute, gray, dewdrop-sized colonies. When they are grown with other microbes and especially with *staphylococcus pyogenes aureus* the colonies are larger and denser. The vitality of colonies on culture media is eighteen days. They are aerobic and grow only between 43° and 26° C. The bacilli stain slowly, and best with Loeffler's alkaline methylene blue. An exposure of from five to ten minutes to the stain is advisable (Davis).

Improved culture media for the influenza bacillus described. They include, blood boiled in agar, agar containing the clear colorless fluid resulting from boiling blood in water, and agar containing blood which has been broken down by the action of strong mineral acids. If a small quantity of brilliant green be added, the media become actively selective for the influenza bacillus by inhibiting the growth of pneumococci, streptococci, and staphylococci. Blood serum from influenza patients agglutinates the organism in dilutions of from 1 in 8 to 1 in 1000, while the serum from normal persons fails to agglutinate the organism even in a 1 to 4 dilution. Alexander Fleming (Lancet, Jan. 25, 1919).

According to some, influenza arises from the combined attacks of the Pfeiffer bacillus and other pathogenic germs—possibly with temporarily heightened virulence,—such as the pneumococcus, streptococcus, *Micrococcus catarrhalis*, staphylococcus, etc. What is more certain is that, whatever be the true, primary virus, the complications, including especially pneumonia, are due to one or more of the organisms just mentioned, including, sometimes, the Pfeiffer bacillus itself.

The original researches of Nicolle and Lebailly, of Dujarric de la Rivière, and of Gibson, Bowman, and Connor, conducted in relation to the 1918 pandemic, resulted in at least a strong suspicion that the primary germ of influenza is a filtrable virus. Olitzky and Gates (Jour. of Exp. Med., Mar., 1923) isolated and cultivated from the nasopharyngeal secretions of 6 patients suffering from the early stages of epidemic influenza an organism which they found capable of reproducing characteristic symptoms in rabbits, including pulmonary lesions that rendered them susceptible to

secondary invasion. This *Bacterium pneumosintes* caused the development of specific antibodies in the serum of rabbits, and these same antibodies could be demonstrated in the serum of patients convalescent from influenza. These antibodies could be developed in rabbits by the subcutaneous injection of suspensions of killed *B. pneumosintes*, and rabbits so injected were immune to subsequent infection with this organism, this protection lasting about 5 months. Injection in human beings brought about the same evidence of immune bodies in the blood serum.

The author regards with considerable skepticism Olitzky and Gates's *Bacterium pneumosintes*. Hottinger found in rabbits after intratracheal injection of sodium chloride solutions such changes as they report after injections of these cultures. He holds that the germ he isolated in 1891 is the most probable cause. Pfeiffer (Deut. med. Woch., Jan. 2, 1924).

**PATHOLOGY.**—There is practically no distinctive pathology of uncomplicated influenza, the lesions present being merely those of acute inflammation of the respiratory mucous membranes. When, as is not infrequently the case, the accessory nasal sinuses are involved, the profuse mucopurulent discharge typically met with in sinus disease is witnessed. In the very rare cases of death from uncomplicated influenza, the inflamed condition of the mucous membranes has not been found perceptible post-mortem.

The chief pathological interest of influenza is that relating to its pneumonic complications. The primary virus is looked upon as so reducing the general powers of resistance to bacteria that organisms already present in the throat or introduced from the exterior readily

invade the deeper respiratory tract and cause pneumonia. Upon this secondary infection may be superimposed, immediately or after an interval, tertiary or quaternary infections with different organisms, which may or may not alter the lesions already produced.

MacCallum, in a study of pneumonia following influenza in army camps and at the Johns Hopkins Hospital, found it possible to differentiate pathologically between the secondary pneumonias due to the pneumococcus, the streptococcus, and the influenza bacillus. (1) In pneumococcal pneumonia, the lung on external inspection showed a lobular consolidation, usually affecting the posterior and lower part of each lobe. The cut surface showed a lobular consolidation corresponding in its details to the consolidation commonly described in the stage of engorgement in lobar pneumonia. Microscopically these areas showed marked dilatation of the ductuli alveolares, while the alveoli contained an exudate of fluid, fibrin, a few leucocytes and mononuclear cells, and often numerous red blood cells. At later periods, every transitional stage of pneumonia could be found, up to the most advanced lobar consolidation, with dense gray hepatization. (2) In streptococcal pneumonia, the interlobular septums were edematous, and the area of consolidation indefinitely outlined—in places red or almost black, due to laking of blood. The bronchi and alveoli were packed with leucocytes, blood, fibrin, and tangled masses of streptococci. The capillaries were often plugged with hyaline thrombi, and the bronchial walls infiltrated with leucocytes, the epithelium being lifted up or destroyed. Whole areas of lung, although retaining their form, were entirely necrotic, the alveoli being

packed with almost solid masses of streptococci, and the lymphatics likewise replete with them. (3) In Pfeiffer Bacillus pneumoniae, the bronchi exuded thick, yellow pus and the lung, though in large part air-containing, was studied throughout with shotlike nodules or somewhat larger, firm patches having a grayish yellow cut surface. The exudate in the bronchi contained leucocytes and numerous influenza bacilli, mostly intracellular. The bronchial walls were greatly thickened by infiltration with mononuclear cells, and the alveolar exudate, while usually rich in leucocytes, often consisted mainly of desquamated epithelium and dense fibrin, with extremely few influenza bacilli. Organization with fibrous tissue was advancing rapidly, the process being essentially an interstitial bronchopneumonia.

**PROGNOSIS.**—Death from uncomplicated influenza is rare, occurring in but a small fraction of one per cent. of the cases. Marked danger attends the disease, however, in certain epidemics from the liability to pneumonic or other complications. As many as one third of the cases may develop pneumonia, and of these, from 10 to 40 or 50 per cent. succumb. Greater likelihood of serious complications exists among those enfeebled by such chronic affections as tuberculosis, chronic bronchitis, myocarditis, nephritis, and emphysema, as well as among the very old or very young, than among other subjects. The liability to complications seems to vary markedly in different epidemics.

**PROPHYLAXIS.**—Immediate isolation of influenza cases is capable of limiting the spread of the disease, but must be carried out most strictly and persistently if it is to be effective. In

hospitals, convalescents should be separated from active cases, and especially, cases complicated with pneumonia should be kept separate, not only from uncomplicated cases, but from cases harboring different pneumonia-producing germs, as unfortunate results through cross-infection from one patient to another have been observed. Personal prophylaxis consists chiefly in avoiding street cars and all places where people congregate, in wearing a proper gauze mask (consisting of at least 5 layers of fine-meshed gauze, and with some provision for protection of the eyes), in washing the hands after contact with possibly contaminated objects, and in keeping away from persons harboring the disease. Nasal irrigations and gargling with saline or antiseptic solutions may be serviceable, but at least the first of these seems open to the objection that the infection may be spread over previously unattacked areas of mucous membrane. Quinine in small doses may possibly be of some prophylactic value. Marchant has suggested the liberal application to handkerchiefs of a fluid made by adding 120 drops of oil of cinnamon and 60 drops of formalin to 1 ounce (30 c.c.) of alcohol.

Mixed vaccines seem to have proven less effectual in protecting from the primary virus of influenza than from the secondary pneumonic infections. Since the latter, however, constitute the chief cause of mortality, vaccine prophylaxis in this direction, if feasible, is of considerable importance.

Examination of sputum and posterior nasal swabs in influenza showed a mixed and fairly constant flora. Such

organisms as streptococcus, pneumococcus, *M. catarrhalis* and *B. influenza* were present in a high percentage of cases. The predominating organism being *M. catarrhalis* in 34 per cent., streptococcus in 30 per cent., pneumococcus in 26 per cent., *Staphylococcus aureus* in 8 per cent., and *B. influenza* in 2 per cent. Prophylactic vaccination on 2 or 3 occasions with a weekly interval between each inoculation is without risk, increases the immunity of the individual, and prevents the onset of pulmonary complications. Cases with high pyrexia or toxic condition from the start should be treated with polyvalent antistreptococcus serum, 20 c.c. subcutaneously, as soon as possible, to be followed by daily injections of 10 c.c. for 3 or 4 days. Calcium lactate, 5 grains (0.3 Gm.) should be given daily for 7 to 10 days to ward off serum sickness. Vaccine treatment may be combined with this, if required. Whittingham and Sims (Lancet, Dec. 28, 1918).

At the State School, Wrentham, Mass., during the influenza epidemic 71 employees were vaccinated with influenza vaccine "B." Of these 5 later contracted influenza. Fifty-eight were not vaccinated; of these 38 contracted the disease. G. L. Wallace (Boston Med. and Surg. Jour., Apr. 17, 1919).

During the influenza epidemic at Camp Sherman, Ohio, all members of the command were required to gargle twice daily with a 1:10,000 quinine gargle. Friedlander, McCord, Sladen, and Wheeler (Jour. Amer. Med. Assoc., Nov. 16, 1918).

Only 12 mild cases of influenza developed among 1500 malarial patients deeply under the influence of quinine. Roccavilla (Rif. med., Feb. 1, 1919).

Testing a widely used vaccine containing Pfeiffer bacilli, streptococci and pneumococci, writers found 4.1 per cent of influenza among 2873 vaccinated as against 4.8 per cent. among 3193 unvaccinated. Jordan and Sharp (Jour. of Inf. Dis., Apr., 1921).

Inhalation of very dilute iodine fumes in a room or from an inhaler

suggested as prophylactic. Sajous (N. Y. Med. Jour., May 15, 1920).

Placing on tongue every 3 hours or oftener of 2 or 3 drops of equal parts of tincture of iodine (B. P.) and honey recommended. J. A. Taylor (Brit. Med. Jour., May 28, 1921).

None of 24 children and 21 adults given iodine during an epidemic developed the disease, except certain infants. Stettner (Münch. med. Woch., Mar. 3, 1922).

**TREATMENT.**—The influenza patient must be put promptly to bed and kept there well beyond the febrile period. Experience appears definitely to indicate that this measure not only reduces the severity of the disease and shortens the period of recovery, but tends to diminish the frequency of pulmonary and other complications. According to H. A. Christian, who calls attention to the frequency with which pneumonic changes in epidemic influenza exist unsuspected by the attending physician, the patient should remain abed for 1 week after defervescence in all cases in which the temperature at any time has risen above 101° F. (39.4° C.) for more than one observation during the 24 hours. Of 60 nurses and internes put to bed as soon as they became ill, none died, while all about them the wards were filled with dying patients, many of them neglected before admission and unable to have continuous rest in bed. During epidemics it is even advisable to have the apparently healthy take their temperature two or three times a day in order that fever, which may precede definite sensations of illness, can be immediately detected and the rest treatment begun as soon as possible (Dubé).

Plenty of fresh air should be admitted to the sick room, but it is of

great importance to *prevent chilling* of the influenza patient's body, as such chilling seems to interfere with the development of immunity and promote complications. The influenza patient often sweats, and the resulting wet garments predispose to chilling; frequent change of the body coverings may therefore be indicated. Upon their removal, the patient should be rubbed dry with a warm towel and warm, dry clothing donned without exposure from beneath the bed covers. Use of the urinal and bedpan should be ordered, to obviate the chilling which inevitably occurs when other procedures are followed.

**Open air treatment** of influenza recommended. The patients do not thrive as well in any ordinary hospital, no matter how well ventilated, as when they are put right out into the open, getting the direct sunlight all day long. Brooks (Amer. Jour. Public Health, Oct., 1918).

The diet in influenza should be simple, but the patient should, as a rule, be encouraged to take all the nourishment he can ingest without aversion, as the disease is *par excellence* one in which the resisting powers of the body must be conserved and everything possible done to facilitate the development of immunity. Milk, broths, gruels, and custards are suitable at first; later, one may gradually add or substitute soft foods such as eggs, milk toast, oysters, ice cream, cereals, etc., and finally return to an ordinary simple, solid diet. *Vomiting* may require abstention from food or limitation to a very light, liquid diet for a day or two. Horder, for vomiting, gives 1 minim (0.06 c.c.) of tincture of iodine in 1 dram (4 c.c.) of water every hour for 6 doses.

Fever in the influenza patient does not, as a rule, require any direct treatment, but **cool sponging** is sometimes indicated for continuously high fever.

The *headache, backache, and pains in the extremities* are appropriately treated with such drugs as **acetylsalicylic acid, sodium or other salicylate, acetphenetidin, antipyrine, pyramidon, or acetanilide**. A disadvantage of these agents is that they may induce an uncomfortable and even dangerous—owing to the possibility of chilling—degree of sweating, which the influenza patient very easily develops. As little as  $2\frac{1}{2}$  grains (0.15 Gm.) of acetylsalicylic acid will sometimes cause a marked sweat. The very smallest dose sufficient for pain relief should therefore be used. Two grains (0.12 Gm.) of **acetphenetidin** or **pyramidon**, given every hour, may give complete relief within a few hours; where pain is severe, **codeine phosphate**,  $\frac{1}{2}$  grain (0.03 Gm.) may be added to the antipyretic, provided its antitussic action does not contraindicate (Fantus).

For obstinate vomiting, interdict food and fluid by mouth for 24 hours, and give **rectal saline injections** containing 2 teaspoonfuls of sodium bicarbonate to the quart. Fantus (Jour. Amer. Med. Assoc., Nov. 23, 1918).

Following capsules used with excellent results: **Quinine salicylate**, 0.20 Gm. (3 grains); **acetphenetidin**, 0.15 Gm. ( $2\frac{1}{2}$  grains); **camphor**, 0.02 Gm. ( $\frac{1}{2}$  grain); given *t. i. d.* While the remedy lowers the temperature somewhat without causing perspiration, it acts primarily upon the neuralgic pains. H. Lychou (Svenska Läk. Forh., Nov. 30, 1918).

**Hot mustard fomentations** used to relieve pain from coughing, and **cold enemas and tepid sponging** to allay fever and nervous symptoms. J. T. Wood (Northw. Med., July, 1921).

Free perspiration favored by ingestion of **hot water**, together with 3 to 5 grains (0.2 to 0.3 Gm.) of **acetylsalicylic acid** every 3 to 5 hours, followed by 1 to 2 drams (4 to 8 c.c.) of **whiskey** and a glass of hot water. S. Friedman (Amer. Med., Feb., 1922).

The most important indication during the 1923 epidemic was **absolute confinement to bed** from onset till there had been a continuous absence of fever for 48 hours. **Calomel, Dover's powder** and **acetphenetidin** were the main remedies. On the 2d day the writer invariably began administration of moderate doses of **sodium citrate**, and this measure was kept up throughout the febrile period in uncomplicated cases. B. M. Randolph (Med. Jour. and Rec., Jan. 16, 1924).

*Cough*, when painful or disturbing, can be controlled with small doses of **codeine phosphate** or of **diacetylmorphine hydrochloride** to favor expectoration, Fantus, in mild cases, uses **ammonium chloride** in 5 grain (0.3 Gm.) doses, with a flavoring syrup vehicle, taken every 2 hours in  $\frac{1}{2}$  tumblerful of water. In more severe cases, 2 grains (0.12 Gm.) of **sodium iodide** may with advantage be combined with each dose of the **ammonium salt**. To support the resulting secretory effect, fluids, such as milk, lemonade, or dilute grape juice, should be given. Fantus advises against codeine or opiates except in the event of a useless, non-productive cough in a patient whose chest is free of physical findings.

Where *coryza* is particularly marked, small amounts of **quinine sulphate, powdered camphor, and extract of belladonna leaves** may be given in combination with whatever analgesic drug is being used.

For influenzal sinusitis the writer prescribes **menthol**,  $\frac{1}{2}$  dram (2 Gm.);

tincture of **eucalyptus**, 3 ounces (90 Gm.). A teaspoonful of this is put in a pint ( $\frac{1}{2}$  liter) jug of steaming water, and the vapor inhaled up and down the nose every 2 or 3 hours. It generally relieves pain, frequently stimulates a free discharge, and patients are satisfied that it "clears the head." Relief to the frontal and sphenoidal sinuses may be secured by packing the neighborhood of the middle meatus, for a few minutes every day, with a pledget of cotton soaked in **cocaine** (5 per cent.) and **adrenin**. When the acute stage is past, a simple **alkaline nose lotion** may be employed. Inflammatory troubles of the pharynx and larynx are treated on ordinary principles. St. Clair Thomson (Pract., Jan., 1919).

*Sleeplessness* in influenza is often due to cough, and will then pass off when the latter is relieved. Frequently, however, a remedy which will simultaneously exert a mild hypnotic effect is desirable. Such remedies are **barbital** and **chloral hydrate**, in 5 grain (0.3 Gm.) doses. **Sulphonethylmethane** (trional), **bromides**, and **scopolamine hydrobromide** in small doses might also be used. Relief is very necessary, since sleeplessness weakens resistance and favors prostration. As a rule, remedial measures are required for only a few nights, although in some instances insomnia proves troublesome even after subsidence of the acute symptoms.

Initial purgation with **magnesium citrate** solution or a similar agent is often recommended, but a number of observers deem it useless. At all events, the bowels should be kept open during the course of the disease, if necessary by means of **enemas**, **suppositories**, or mild **laxatives**.

Warning against the abuse of purges at the start of influenza. In

grave forms with very low blood-pressure, **adrenin** may be useful. The writer gives 10 to 15 drops by the mouth 2 or 3 times. Given subcutaneously, it is apt to cause severe disturbance in these cases. The heart may have to be re-enforced with **camphorated oil** or **strychnine** or both. **Caffeine** is apt to bring on delirium. **Wet packs** about the chest, at 25° C. (77° F.), changed 3 or 4 times a day, render good service. With a tendency to pulmonary edema, **venesection** must be abundant and repeated; otherwise, wet cupping may suffice. The writer advocates moderate doses of **quinine** for its tonic action, *e.g.*, 4 grains (0.25 Gm.), morning and evening. Lereboullet (Paris méd., Nov. 16, 1918).

*Prostration* in influenza is treated, in the first place, by **rest**, **fresh air**, and a sufficient **diet**. Administration of stimulant drugs may be availed of in addition. **Caffeine**, **strychnine**, and **quinine** are available for this purpose, but care should be taken not to induce sleeplessness. Where a tendency to a circulatory impairment is observed, these agents may again prove useful, but injections of **camphor** in oil in amounts of 1 to 2 fluidrams (4 to 8 c.c.) a day, and the use of **digitalis**, **strophanthus**, or **adrenin**, are also available. In cases with pallor, thready pulse, syncopal tendency, and the "white line" phenomenon, Lyon recommends **adrenin** in doses of 5 drops of the 1:1000 solution by mouth every hour, up to 30 or 40 drops a day. Lereboullet sometimes substitutes injections of whole **adrenal extract** from ampoules, each corresponding to  $1\frac{1}{2}$  grains (0.1 Gm.) of the extract.

While there is no specific drug or treatment for influenza, many practitioners have felt convinced that **quinine** is of distinct value. Pos-



sibly, benefit may be obtained through the stimulating action of this alkaloid, in proper dosage, upon phagocytosis,—an action repeatedly observed experimentally. According to H. Lyon Smith the best dosage for this purpose, to be administered during the initial stages, is 1 grain (0.06 Gm.) for every stone (14 pounds) of the patient's weight.

**Calomel** in so-called tonic doses,  $\frac{1}{12}$  grain (0.005 Gm.) every two hours until 1 grain (0.065 Gm.) has been taken, to enhance the antitoxic activity of the liver, followed, if there is no cough, by **sodium benzoate**, 10 grains (0.65 Gm.) every three hours, or, if there is a cough, by **creosote carbonate** (which, though an oil, is preferably given in capsules), 5 grains (0.3 Gm.) every three hours, taken in the midst of a meal when possible to prevent gastric disturbances, has served us faithfully even though pulmonary phenomena had already begun. Editorial (N. Y. Med. Jour., Dec. 21, 1912).

**Alkali** treatment advised in epidemic influenza. The measures used are as follows: Immediate elimination through profuse sweating induced by large bowls of **hot boneset tea**, and divided doses of **calomel**,  $\frac{1}{10}$  grain (0.006 Gm.) every half hour until a grain or more has been given. **Water** given exclusively for the first 24 or 48 hours, and freely throughout the attack. **Hot mustard foot baths** are used, the patient being kept in bed covered with blankets and surrounded with hot water bottles. A teaspoonful of **sodium bicarbonate** to a pint of lukewarm water is given every 4 hours by enema. Also **sodium bicarbonate**  $\frac{1}{2}$  ounce (15 Gm.), **peppermint water** 4 ounces (120 c.c.), one teaspoonful every 2 hours, alternating with the same dose of **potassium citrate**  $\frac{1}{2}$  ounce (15 c.c.), **peppermint water**, 4 ounces (120 c.c.). **Calcium salts** are given in the form of **lime water**,  $\frac{1}{8}$ ; milk,  $\frac{1}{8}$ . Some patients with fulminant attacks of vom-

iting and terrific headaches could not tolerate the **potassium salts**; to such were given only the **sodium bicarbonate** mixture every hour, and the **soda enemas**. Even in severe cases the soda relieves the early pains in 24 to 48 hours. T. C. Ely (N. Y. Med. Jour., Apr. 5, 1919).

**Colloid metals** were used in the 1918 epidemic with asserted benefit. P. Richard injected **colloid gold** in the form of gold collobiase intramuscularly in 30 minim (2 c. c.) doses on 2 to 4 successive days in incipient influenza and obtained uniformly a prompt recovery. Capitan used **colloid arsenic** and **colloid silver** in combination in both mild and severe cases, and asserts that this treatment lowered the mortality in cases complicated with pneumonia.

**Sodium salicylate** in full doses destroys or inhibits the Pfeiffer bacillus. To avoid any heart depression the writer combines **digalen** and **caffeine** with it, together with **dionin**, **codeine** or **morphine** if there is much cough. Ryser (Schweiz. med. Woch., Aug. 5, 1920).

Intravenous administration of **sodium salicylate** advocated with a view to relieving pain and restlessness and saving the patient the wear and tear of a severe toxemia. Patients so treated showed rapid convalescence with a minimum of sequels. The measure should not be used, however, if there is evidence of beginning pneumonia. The author also used **magnesium sulphate** intravenously with marked general benefit and relief of edema of the lung and brain; its best effect was at the start of pneumonia and edema. Results from **transfusion of citrated whole blood** were markedly favorable in pneumonia cases even of several days' duration. **Absolute rest in bed** is the most essential element of treatment. A stationary leucocyte count is favorable; a falling count, a danger sign. J. L. Neilson (U. S. Naval Med. Bull., Apr., 1921).

Other remedies recommended include **alkalies**, freely administered, **calomel** in small doses for several days, **mercuric chloride** intravenously, **tincture of iodine** internally, **methylene blue** in doses of 3 grains (0.2 Gm.) 4 or 5 times a day, **hexamethylenamine** intravenously to the amount of 30 to 45 grains (2 to 3 Gm.) a day, **venesection** for cases with dyspnea and cyanosis in the absence of pneumonia, and **salicin**, 20 grains every hour for three or four hours.

The writer treated 225 cases of influenza and pneumonia in the 1918 epidemic without losing a patient. At the first visit he gave a mixture of **tincture of aconite** and **tincture of veratrum viride**, to be continued every half-hour until 6 to 10 doses had been given. At the same time he gives 2 or 2½ grains (0.12 or 0.15 Gm.) of **calomel** in ¼-grain (0.016 Gm.) doses, crushing the tablets and mixing with a little water. Six or 8 hours after the last tablet, 1 or 2 heaping tablespoonfuls of **magnesium sulphate** are taken. This treatment will abort pneumonia in many instances. On the first indication of a failing pulse or the slightest trace of cyanosis, the best **brandy** or **whiskey** obtainable was given in teaspoonful doses every 3 hours, increased if necessary to a tablespoonful every hour. B. S. Maloy (Trans. Amer. Public Health Assoc.; Med. Rec., Jan. 11, 1919).

Influenza patients treated with **gelsemium** showed improvement greatly exceeding that after any other treatment. Following mixture used:—

**R** *Tr. gelsemii* ... ℥xij (0.73 Gm.).  
*Tr. belladonnae* . ℥v (0.33 Gm.).  
*Potassii citratis*. gr. x (0.66 Gm.).  
*Syr. aurantii* .. 3j (4 Gm.).  
*Aq. chloroformi*  
 ad ..... 3j (30 Gm.).

**Sig.:** One ounce (30 c.c.) 4 hourly for the first 24 hours; thereafter ½

ounce (15 c.c.) every 4 hours until temperature is normal.

When the temperature reaches the normal the remedy should be stopped. In severe toxic cases with marked pulmonary symptoms, where tremor is marked, the pulse unstable, and the patient collapsed, alcohol in the form of **brandy**, **whiskey**, or **champagne** acts best. **Inhalations of menthol** and **benzoin** greatly relieve tightness in the chest. Small and Blanchard (Brit. Med. Jour., Mar. 1, 1919).

Encouraging results seem to have been obtained by the use of **vaccines** for the prevention of complicating pneumonia. At Camp Upton, subcutaneous injection of a lipovaccine containing 10,000 million each of Types I, II, and III of the pneumococcus appeared not only to immunize against these organisms but also to result in a very low incidence of streptococcal pneumonia cases.

A curative vaccine containing 5 millions each of the streptococcus, pneumococcus, and *M. catarrhalis*, and 2 millions each of the meningococcus and *B. influenzae* was used in early cases by Whittingham and Sims with asserted good effect; it was given daily until defervescence occurred. In cases showing high pyrexia or a toxic condition from the start, 20 c.c. of polyvalent **antistreptococcic serum** was also given, followed by daily injections of 10 c.c. for three or four days.

Prompt treatment with **vaccines** (pneumococci, streptococci, and influenza bacilli), within a few hours of the onset will definitely abort an attack of influenza. Where bronchopneumonia is present from the first, vaccine seems often to have the same good effect, when injected early.

The fall of temperature is associated with improvement in the patient's aspect and in the pulse and respiration rate, thus indicating that

it is due to a definite immunizing influence. Inadequate dosage is to be avoided. Wynn (Pract., Feb., 1919).

**Bacterial protein injections** employed in influenzal pneumonia. In spite of massive consolidation, good results were obtained when there was a definite reaction following the injection, and the authors therefore came to believe that the results were dependent upon a "non-specific protein" reaction. A vaccine made from the prevalent organisms, however, was used. A saline suspension of heat killed organisms was made, so that each cubic centimeter contained 100 million influenza bacilli, 100 million pneumococci, types I, II, and III; 100 million streptococci, and 100 million staphylococci. The initial dose was 5 c.c. and this was doubled daily until four doses had been given. Later they used 1 c.c. as the initial dose and regulated the succeeding doses by the amount of reaction. Reaction occurred as a rule about  $\frac{1}{2}$  hour after the injection. Out of 86 cases treated expectantly there were 27 deaths, a mortality of 31.2 per cent. Of 200 cases treated with protein injections, there were 19 deaths, a mortality of 9.5 per cent. Roberts and Cary (Jour. Amer. Med. Assoc., Mar. 29, 1919).

A monovalent **antistreptococcus serum** used in critically ill cases. Whenever specific agglutination was obtained, marked improvement followed injection of the serum. Rose-now (Jour. of Inf. Dis., June, 1920).

In all severe cases, particularly those with pneumonia, the writer gives **diphtheria antitoxin**, 1000 units, and also 10 c.c. of polyvalent **antistreptococcus serum**. The temperature is usually reduced to normal, he finds, in 48 hours. Kadysz (Polska gaz. lek., July 30, 1922).

**Pooled serum from convalescent** influenzal bronchopneumonia patients at the U. S. Naval Hospital, Chelsea, Mass., was used by McGuire and Redden in 151 pneumonia cases.

The mortality was greatly lowered and the disease shortened. The maximal amount of serum administered (intravenously) at a dose was 250 c.c.; the usual amount, 75 to 125 c.c. Most patients received a total of about 300 c.c.

The writer employed intravenous injections of from 75 to 100 c.c. of **citrated convalescent blood** in the treatment of 54 of the severest cases of pneumonia following influenza, and reduced the mortality to 27 per cent.

The reaction produced was about like that observed after the use of antipneumococcic serum in lobar pneumonia.

The temperature often fell by crisis, sometimes after a single injection, at others after 2 or 3 injections in 36 hours. More commonly, however, the fall was by rapid lysis. Maclachlan and Fetter (Jour. Amer. Med. Assoc., Dec. 21, 1918).

In 24 cases of the grave septicemic forms of influenza with various circulatory lesions, the author gave daily subcutaneous or intramuscular injections of 10 or 20 c.c. ( $2\frac{1}{2}$  or 5 drams) of the **whole blood of convalescents** until fever subsided. Twenty cases recovered. From 2 to 8 injections were required. A brief chill usually followed 3 or 4 hours after an injection. The general condition was improved, dyspnea soon relieved, and diuresis induced. Simici (Paris méd., June 3, 1922).

Special stress has been laid upon the use of **antipneumococcic serum, Type I**, in cases in which this type of pneumococcus is found. It seems preferable, however, to use the serum at once without waiting for the results of laboratory examination, to avoid the loss of valuable time.

The other therapeutic measures indicated in influenzal pneumonia are those employed in pneumonias unrelated to influenza. Coryza, bron-

chitis, sinusitis, gastritis, and other complications are likewise treated as under other conditions.

In over 6000 cases treated at Camp Dix, distressing cough was relieved by **codeine** or **heroin**. **Medicated steam inhalations** were helpful for laryngeal irritation. **Digitalis** was started early in the pneumonia cases, given in full doses for 48 hours, and then discontinued or reduced in dose when the heart was well digitalized. If abdominal distention developed, it was relieved by **enemas** or **pituitary solution** administered by the hypodermic route.

**Water** was given by rectum, subcutaneously or intravenously if the patient was toxic or unable to take fluid freely by mouth. The **Trendelenburg position** proved helpful in a few cases with pulmonary edema. The diet should provide over 3000 calories daily, and be made up of gruels, broths, purées, eggs, and milk fortified with cream and lactose. **Serum** was given in cases of pneumonia due to Type I pneumococcus, preliminary desensitization being practised in every case. It was given intravenously in doses of 60 to 100 c.c. every 12 hours until the temperature remained below 101° F. 38.3° C. **Spinal puncture** was made in all cases showing symptoms of meningeal irritation, the precipitin test for pneumococcus type made on the fluid, and **serum** in a 20 c.c. dose given intraspinally at once if Type I proved present. At the same time a desensitizing dose of serum was given and 5 hours later a dose administered intravenously. Synnott and Clark (Jour. Amer. Med. Assoc., Nov. 30, 1918).

In intensely toxic cases with a tendency to paralysis of the vasomotor centers, the writer found the effectual treatment is **adrenin**. Subcutaneous or intravenous injections of 0.001 Gm. ( $\frac{1}{4}$  grain) several times a day keep the pulse going well but do not modify conditions in the lungs. A **fixation abscess** seemed to do good service in some cases. F. Wan-

ner (Corresp.-Blatt. f. schweizer Aerzte, Dec. 28, 1918).

Subcutaneous or intramuscular injections of **sodium nucleinate**, to stimulate production of leucocytes, are advocated by the writers, together with **sodium bicarbonate**, 1 dram (4 Gm.) every 4 hours, and as much **glucose** in the food as the patients will take. In the worst cases glucose is given also by rectum, subcutaneously, or intravenously in a 3 per cent. solution, with sodium bicarbonate, 2 per cent. Other measures are **calomel** and **salines**, **camphor** in oil and **caffeine**, and for marked purulent expectoration a mixture containing **potassium iodide** and **creosote**. The diet for these patients consists of milk and glucose and dilute albumin-lemon-glucose-barley water. Twelve deeply cyanotic cases recovered under this treatment. Willmore and Gardner-Medwin (Lancet, Jan. 21, 1922).

For the persistent **neuralgia** and **neuritis** following influenza the customary analgesic drugs may be used, along with general roborant treatment. Blum, of Strasbourg, found **methylene blue**, 3 grains (0.2 Gm.) 4 or 5 times a day, of distinct value in obstinate neuritis. **Fresh air**, **sunshine**, **change of climate**, a generous diet, **iron**, and **strychnine** are also helpful or even essential. Where muscular weakness and atrophy result, **electricity**, **hydrotherapy**, and **massage** are indicated.

Capillary hemorrhages in influenza indicate, according to Lesné, a vasodilating action by the disease toxins, and justify the use of **adrenin** in large doses.

Where cough and expectoration persist for several weeks and arouse fear of developing tuberculosis, Nammack has found a combination of **terpine hydrate**, **creosote**, and **strychnine** useful.

Post-influenzal empyema indicates pleurotomy, whether the causal organism is the pneumococcus, streptococcus, or other germ. The incision should be made, as usual, in the eighth or ninth interspace, in front of the posterior axillary line, but is to serve only for the evacuation of the pus and the admission of a finger to determine the lowest point of the corresponding pleura. Here drainage should be instituted, either through a second incision 6 to 8 centimeters long, or by prolongation of the first incision to the eighth or ninth rib, which should thereupon be resected in the anterior axillary line. Incision of the pleura should next be effected under control of the intrapleural finger. The evacuation of membrane should always be completed with a wad of cotton mounted on long forceps. One or 2 large drains are placed in the anterior incision. The post-operative treatment consists in intermittent irrigation through 1 to 3 Carrel tubes introduced in the first incision. Bérard and Dunet (Bull. de l'Acad. de méd., Dec. 17, 1918).

The writer terms "lingering influenza" cases which resist ordinary treatment, have an unduly protracted convalescence, or show persisting toxemia and focal infection. The symptoms are those of a toxemia or of a focal infection with many manifestations, and of an inflammation or irritation of some portion of the respiratory tract with a tendency to hemorrhage. Usually, demonstrable disease of the upper respiratory tract is present, with a history of previous attacks of upper respiratory infection. **Removal of the focus of infection** is essential. After this a vaccine is given containing all the organisms shown by the whole-blood test to be pathogenic to the patient, the smears for the test cultures being taken from all parts of the upper respiratory tract. M. Solis-Cohen (Amer. Jour. of Clin. Med., Jan., 1924).

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## INFUSIONS, SALINE.

**INTRAVENOUS INFUSION.**—By this method saline solution, plain or medicated, is introduced directly into a vein as distinguished from intra-arterial infusion and hypodermoclysis.

**Solutions.**—The solution used is usually normal physiological salt solution that is isotonic with the blood—9 parts of sodium chloride to 1000 parts of sterile water. The proportions, however, may vary between 0.6 and 0.9 per cent. In practice it is about 0.7 per cent., being made by dissolving 1 dram of chemically pure sodium chloride in 1 pint of water. This solution is sterilized by heat and filtered into flasks sterilized by washing with bichloride solution and rinsing afterward with sterile water, the mouth of the flask being tightly stopped with sterilized non-absorbent cotton.

The flasks and contents after being thus prepared are sterilized for one hour on three successive days at a temperature of 220° F. After the last sterilization the cotton stoppers and mouth of the flasks are covered with a small square of thin rubber tissue held in place by a rubber band. When needed for use the flask is placed in a deep vessel filled with hot water, and left there until the contents are raised to the proper temperature.

Another method is to heat one of the flasks until the contained solution boils. A portion of the cold solution is poured into the reservoir first, and its temperature is raised by adding sufficient of the boiling solution.

Solutions other than plain saline have been suggested for use with the idea of approaching as nearly as possible the identity of the blood-serum. The following (called artificial sera) are most in favor:—

### Hare's formula:—

Calcium chloride .... gr. iv (0.25 Gm.).  
Potassium chloride .. gr. iss (0.1 Gm.).  
Sodium chloride ..... 3ii¼ (9 Gm.).  
Distilled water ..... Oij (1000 c.c.).

### Hayem's formula:—

Sodium chloride ... 3i¼ (5 Gm.).  
Sodium sulphate .. gr. xv (1 Gm.).  
Distilled water .. .. Oij (1000 c.c.).

**Locke's formula:—**

Calcium chloride ..... gr. iv (0.24 Gm.).  
 Potassium chloride ... gr. viiss (0.42 Gm.).  
 Sodium bicarbonate ... gr. iiss (0.15 Gm.).  
 Dextrose ..... gr. xv (1 Gm.).  
 Sodium chloride ..... 3ii¼ (9.2 Gm.).  
 Distilled water ..... Oij (1000 c.c.).

**Ringer's formula:—**

Calcium chloride ..... gr. iv (0.26 Gm.).  
 Potassium chloride ... gr. i¼ (0.075 Gm.).  
 Sodium chloride ..... 3ii¼ (9 Gm.).  
 Distilled water ..... Oij (1000 c.c.).

**Szmann's formula:—**

Sodium chloride ..... 3iss (6 Gm.).  
 Sodium carbonate .... gr. xv (1 Gm.).  
 Distilled water ..... Oij (1000 c.c.).

**Tyrode's formula:—**

Calcium chloride .. . gr. iij (0.2 Gm.).  
 Potassium chloride .. gr. iij (0.2 Gm.).  
 Magnesium chloride .. gr. iss (0.1 Gm.).  
 Sodium bicarbonate .. gr. xv (1 Gm.).  
 Disodium phosphate .. gr. ¾ (0.05 Gm.).  
 Dextrose ..... gr. xv (1 Gm.).  
 Sodium chloride ..... 3ij (8 Gm.).  
 Distilled water ..... Oij (1000 c.c.).

**Apparatus.**—This comprises a graduated glass irrigating jar with a capacity of 1500 c.c., provided with a thermometer and about 6 feet of ¼-inch rubber tubing, terminating in a venipuncture needle or infusion cannula; bandage to constrict the arm, and a gauze compress and bandage for postoperative dressing.

**Asepsis.**—The apparatus should be boiled; the thermometer should be placed in a 1:500 solution of bichloride for ten minutes, and then rinsed in sterile water. The operator's hands and the patient's skin should be aseptized.

**Details of the Solution.**—The temperature of the solution should be at least 105° F., and, should the added stimulating effect of heat be desired, it may be 115° F., or even 118° F. This seemingly high temperature of the solution will be lowered 2° or 3° in flowing from the reservoir to the site of operation. In any case the solution should be introduced at a uniform temperature throughout, and the thermometer in the reservoir will indicate when it is necessary to add hot solution.

The rapidity of the flow may be regulated in two ways: By raising or lowering

the reservoir, or by compression on the rubber tube by fingers or clamp. The usual rate of delivery is from five to ten minutes for each pint of solution. If the heart is weak more time must be consumed or acute dilatation of the heart may be produced. If the delivery is too rapid it may happen that the fluid passing from the heart to the lungs may be nearly pure salt solution. Very soon difficult respiration and restlessness will ensue as a result of imperfect oxygenation of the blood; in

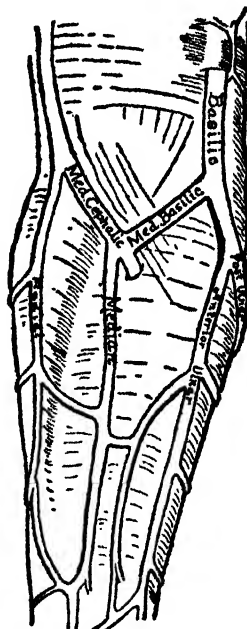


Fig. 1.—The superficial veins of the forearm.  
 (Ashton.)

this case the infusion must be interrupted until these untoward symptoms disappear.

The amount of solution infused usually varies from 1 to 3 pints, being governed by the return of the pulse, the increase in its volume, and by the improvement in the color of the patient's skin. It will be readily appreciated that the capacity of the circulatory apparatus is limited, and that if this limit is exceeded the solution will escape into the tissues and produce edema. Larger quantities of solution may be needed, however, after venesection or severe hemorrhage. As a rule, it is wiser to repeat the infusion two or three times

during the twenty-four hours than to infuse too much at one time.

**Operative Site.**—The median basilic vein, which runs across the bend of the elbow from without inward, is the favorite site. Dawbarn and others have advised the use of the internal saphenous vein anywhere above the ankle for the reasons that it is as large or larger, that there are no important structures nearby, that the scar left is unobjectionable as to location, and that the assistants will interfere less with the operating surgeon than if the arm is used.

In infants the superior longitudinal sinus may be injected where entrance into superficial veins is impracticable. At times, too, the external jugular vein can be employed in children whose fontanel has closed; this route is also frequently a satisfactory one in adults.

**Preparation of the Patient.**—The area around the site selected for the infusion should be bared of clothing, and the garments about the axilla, if the arm is selected, should be loosened. The bend of the elbow may be shaved, scrubbed with warm water and soap, washed with bichloride solution (1:2000), and rinsed with sterile water. More commonly, however, the skin is merely painted with tincture of iodine and washed with alcohol or benzine. To compress the veins and make those below more prominent a piece of sterile bandage or Esmarch constrictor is tightly tied above the elbow.

If an incision over the vein is to be made the site of entrance is anesthetized by infiltration with a freshly prepared 0.2 per cent. cocaine solution, a 1 or 1.5 per cent. procaine solution, by freezing with ethyl chloride spray or, in emergencies, with a small lump of ice dipped in salt.

**Operative Technique.**—Intravenous infusion is generally performed without incising the skin. A vein puncture or hypodermic needle, or a small aspirating needle is employed for this purpose, instead of the blunt cannula used in the older incision method. The needle, with the solution flowing through it, is inserted through the skin directly into the vein. This having been done, the bandage above the elbow is removed and the solution allowed to enter the circulation, the reservoir being raised

from 2 to 6 feet above the patient to secure the necessary pressure. The thermometer in the reservoir is watched, in order that the temperature of the solution may be kept uniform. Furthermore, the fluid in the reservoir must be carefully replenished before it has entirely escaped; otherwise, air will enter the vein when a fresh supply is added.

For injection of the external jugular vein, the child is placed on its back, with a roll of cloth or cotton under the shoulders to enable the head to fall backward. With the head now turned to one side, the vein is usually visible just beneath the skin. Slight pressure by the nurse on the vessel just above the clavicle, and any crying by the infant, further facilitate the procedure. If the vein does not appear, it may be made to do so if the patient can close the lips and try to blow several times. With the thumb of the left hand steadying the vessel by pressing down gently on it, the needle, with its bevel directed upward, is inserted just beyond. After the injection, slight pressure will stop any bleeding; the puncture is mopped with alcohol, and a small gauze and adhesive dressing applied (Waters).

The *incision method* may be carried out either with or without a cut into the vein itself. It is objectionable, especially in women, because it leaves a scar, but has the advantage of exposing the actual injection of the vein to the operator's vision, thus largely obviating difficulties as to entrance of the needle, puncture of the opposite side of the vein, escape of fluid into the surrounding tissues, etc. In general, the use of the incision method is limited to cases in which, because of excess of fat or other reasons, the veins cannot be made visible or palpable. In carrying out the incision method, the forearm is supinated and a transverse incision made over the median basilic vein (Fig. 2), which is loosened from the adjacent structures for a distance of from 1 to 1½ inches, then brought out of the wound. Two catgut ligatures are passed beneath it by means of an aneurism needle or a pair of thumb forceps. One ligature is placed as low down on the distal portion of the vein as possible and tied. The second ligature is placed as high up as possible on the proximal por-

tion of the vein, ready to be tied. A short distance from the distal ligature the exposed vein is grasped in the mouse-toothed forceps, and, while the vein is on the stretch, an oblique cut is made with the scissors through half the vein, exposing its interior. Allowing the solution to flow through the cannula to expel any air or cooled fluid, the cannula with the solu-

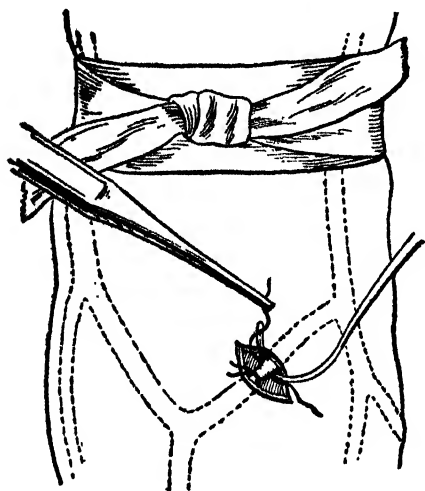


Fig. 2.—Intravenous saline infusion. (Morrow.) Incision method, showing the incision made, the distal end of the vein tied, and a second ligature being passed under the proximal end of the vein.

tion still flowing through it is inserted well up into the proximal portion of the cut vein, and is retained in place by tying the second ligature (Fig. 3), preferably in a bow-knot, that it may be easily loosened when the cannula is withdrawn.

When the desired amount of solution has been infused, the ligature around the cannula is loosened slightly and the cannula removed. The same ligature is now used to tie off the proximal end of the vein. The wound is closed with catgut sutures, and a sterile gauze compress applied and retained by a gauze bandage.

*Continued intravenous drip*, kept up usually for 1 to 6 days, recommended as a secondary measure to follow the primary massive intravenous infusion of saline or glucose solution which, in profoundly shocked, exhausted and starved surgical patients, is often ephemeral in its effects. A 1 liter

container, tube with Murphy "drip bulb," thumbscrew clamp for control of rate, metallic cannula with shoulder tip, and Duchesne electric pad for maintenance of uniform temperature are used. The median basilic or other prominent vein is used. The cannula and end of the delivery tube are immobilized by adhesive strips and a bandage, and the whole arm and hand bandaged to a padded splint, secured to the bed or side table in restless patients. The average flow should be 40 to 60 drops a minute, increased temporarily to 150 if the pulse is empty or thready. When the temperature is falling or hypothermic, the solution should be at 100 to 104° F., at least, at the cannula. When glucose is infused, the procedure is incomparably superior to all other methods of parenteral nutrition and medication. R. Matas (Ann. of Surg., May, 1924).

Description of a simple apparatus which advantageously replaces the ordinary gravity method of saline infusion. The entire apparatus can be sterilized already set up, and the saline is run in under pressure, which may be regulated to suit the desire of the operator.

The reservoir consists of an ordinary Erlenmeyer flask into which an out-



Fig. 3.—Intravenous saline infusion. (Morrow.) Incision method, showing the cannula tied in place.

let nipple has been blown at one side of the bottom. To this outlet is attached tubing leading to needles for intravenous or subcutaneous administration. Through the stopper of the flask passes a short glass tube to which is adapted a rubber bulb. In using the device, the solution is placed in the flask, the stopper replaced, the tubes cleared of air by brief pressure



on the bulb, the needle or needles introduced, and the solution run into the patient under control of the rubber bulb. With this device the tubes are short and not in danger of being accidentally torn loose from their connections, and it is almost impossible to spill the solution. W. H. Byford (Jour. Amer. Med. Assoc., Nov. 29, 1924).

**INTRA-ARTERIAL INFUSION.**—By this method saline solution, plain or medicated, is introduced into an artery instead of a vein.

The solution may be injected into the distal end of the vessel, or into the proximal end against the blood-current. It has been claimed for this method that, being first forced through the capillaries, the solution is received by the heart more gradually and more evenly mixed with the circulating blood. A stimulating effect upon the heart is claimed for the infusion against the blood-current. These advantages, however, are more imaginary than real; intravenous infusion should be the method of choice.

In suspended animation during anesthesia or from other causes Crile and Dolley showed in experiments that the infusion of normal salt solution and adrenalin into an artery against the blood-current is an efficient method of raising the blood-pressure and stimulating the heart, as the blood and solution are driven back to the heart, directly affecting the coronary arteries. By this method they resuscitated apparently dead animals.

In *Crile's intra-arterial method*, the injection is made into the carotid artery or one of its larger branches, the coronary arteries being most directly reached through these vessels.

In *Dawbarn's intra-arterial method* the solution is injected into the femoral artery from an ordinary Davidson or fountain syringe armed with a hypodermic or fine aspirating needle.

These methods have not proven altogether satisfactory, their advantages being greatly overbalanced by the accidents that may follow their employment (Dutton). For further details the reader is referred to earlier editions of the *CYCLOPEDIA*. (Crile's

method was originally published in Amer. Jour. Med. Sci., Apr., 1909).

#### **INTRAPERITONEAL INFUSION.**—

For this procedure, introduced in particular for the relief of dehydration in infants, there are required an infusion reservoir with rubber tubing and a medium sized intravenous needle. The skin of the abdomen having been aseptitized with tincture of iodine and alcohol, the skin and subcutaneous tissue are picked up with the thumb and forefinger and the needle inserted upward through the abdominal wall just below the umbilicus. The solution passes into the peritoneal cavity by gravity, but should be allowed to do so only at a slow rate.

The infusion may continue, in the absence of any untoward signs, until the abdomen is slightly distended.

There is apparently no risk of puncture of the bowel by this procedure. Care should, of course, be taken not to pierce a distended bladder.

Tests have shown that 40 to 60 per cent. of the fluid thus administered is absorbed in an hour, while the remainder is taken up more slowly, prolonging the good effects of the procedure.

Intraperitoneal injection in children considered so superior to other procedures that the writer has almost discontinued the use of enteroclysis, hypodermoclysis and even intravenous injections. After ascertaining that the bladder is empty and that there is no distention, the abdomen is painted with tincture of iodine and carefully washed with alcohol. Normal salt solution at 100 to 103° F. is put into a sterile graduate, the bottom of which is connected by a rubber tube with a needle of 18 gauge with point beveled at 45 degrees. The skin of the abdomen in the midline, about  $\frac{1}{2}$  down from the umbilicus to the pubis, is elevated between the thumb and finger, the right hand plunging the needle with the solution flowing from it through the abdominal wall. Elevation of the container 2 to 3 feet above the abdomen will give the proper rapidity of flow. When slight distention occurs, the needle is withdrawn and a sterile dressing applied. O. W.

Hill (Jour. Tenn. State Med. Assoc., Jan., 1924).

**HYPODERMOCLYSIS.**—This method of subcutaneous infusion is often used as a supplement to intravenous infusion. It is also used for the same purposes as intravenous infusion when time is not important. Like the latter, it is contraindicated in cases of advanced dropsy, pulmonary edema, and of marked cardiac insufficiency, in which latter condition the circulation is so feeble that the solution is very slowly absorbed or not at all.

**Apparatus.**—This is the same as that used for intravenous infusion, with the exception that the cannula is replaced by an aspirating needle of medium size. When the fluid is to be introduced under both breasts simultaneously, a Y-shaped glass connection is used at the distal end of the tubing, allowing the use of two aspirating needles, which are joined to the legs of the Y by shorter lengths of rubber tubing. For emergency purposes an apparatus may be improvised with a glass funnel, rubber tubing, and a hypodermic needle.

**Asepsis.**—The same measures should be taken toward this end that are described under intravenous infusion.

**Details of the Solution.**—As in intravenous infusion, the solution should enter the body at a temperature of 110° F. In using an aspirating needle the temperature of the fluid should be 3° higher, and when a hypodermic needle is used it should be 5° warmer. The solution is not absorbed so rapidly by this method; and with a medium-sized needle and the reservoir elevated about 3 or 4 feet, 1 pint of solution may be injected during about twenty or thirty minutes. When a hypodermic needle is used the reservoir must be elevated 5 or 6 feet to obtain an equal force.

Small injections (from 8 to 16 ounces) repeated in a few hours are better than larger injections given at one time. Hildebrand fixes the limit of quantity to be injected during fifteen minutes at 1 dram to each pound of body weight. If this limit is exceeded the tissues become waterlogged and absorption ceases, the kidneys being unable to excrete the water with sufficient rapidity. Very large injections

should not be made into a single area, as they may cause undue distention and sloughs.

**Injection Sites.**—Those locations are chosen which are rich in loose connective tissue and reasonably free from large blood-vessels and nerves; for example, under the mammary glands, between the iliac crest and the last rib, in the axillæ, and on the inner surface of the thighs. The point of puncture may be anesthetized by the use of cocaine, ethyl chloride, or ice and salt.

**Technique.**—The reservoir, containing the warmed saline solution, and connected up with the tubing and aspirating needle, is first raised 3 or 4 feet and the cold liquid and air are allowed to escape. With the solution still flowing the needle is inserted obliquely into the subcutaneous tissues of the selected site, using steady pressure. As the fluid enters the tissues they become distended, but this distention slowly subsides as the fluid becomes absorbed (massage will hasten the absorption).

It is well to enter the needle well into the tissues at first and when one area becomes distended the needle may be withdrawn a little and the direction slightly changed. By repeating this maneuver the fluid in considerable amount may be spread over a wide area without overdistinging any one portion of the injected tissues. As in intravenous infusion, the temperature of the solution in the reservoir must be maintained at the same point, and the solution must be present in amount sufficient to exclude all chances of air entering the delivery tube.

When the desired quantity of the solution has been injected, the needle is withdrawn, and the finger-tip placed over the entrance to prevent the escape of fluid; later the puncture is sealed with a pledget of sterile cotton dipped in collodion.

#### **PAINLESS HYPODERMOCLYSIS.**

—Willard Bartlett (Annals of Surgery, Feb., 1921) advocates local anesthesia from the beginning to the end of the procedure by introducing very dilute novocaine instead of straight salt solution or distilled water. Gradually increasing amounts of fluids are used, in which the percentage of novocaine is cut down first from ¼

to  $\frac{1}{8}$ , then to  $\frac{1}{16}$ , and finally to  $\frac{1}{32}$  of 1 per cent., without the anesthetic value of the drug being appreciably diminished. The  $\frac{1}{32}$  per cent. novocaine solution suffices for the introduction of fluid under the skin. **Adrenalin** is added where hypodermoclysis is used in shock and hemorrhage. The apparatus is the ordinary 700 c.c. glass drip bottle, a rubber tube 1 yard in length, controlled by a screw clamp, and a slender, long needle. The best site is the flank midway between the lower ribs and the prominent upper curve of the ilium. Less subsequent damage has occurred there than elsewhere, and less pain than under the breast. W.

**INTERNAL EAR, DISORDERS OF.**—The percipient apparatus of the ear is relatively rarely affected and furnishes but 2 to 10 per cent. of the cases in the statistical tables,—the larger figure embracing apparently every case which gives evidence of nerve involvement, however secondary in fact and importance to tympanic trouble. It comprises the congenital defects as well as the central lesions, such as nerve atrophy in tabes, word-deafness from cortical lesion, and many other rare cerebral affections; but the group which most concerns us in this practical review is made up largely of lesions of the labyrinth due to the specific affections, including syphilis.

**TUNING-FORK TESTS.**—The diagnosis of these affections is largely from negative evidence, much of it furnished by the tuning-fork tests of the function, and these had better be here considered.

Tuning-forks can be conveniently used giving tones due to vibrations of from 50 to 2000 per second, and much can be learned by use of  $A = 213$  d. v. s. or  $C = 520$  d. v. s. alone; but it is not best to trust to any one tone. The lower forks must usually

have clamps to dampen the overtones (such can be improvised by slipping bits of rubber-tubing over the ends), and in the absence of such will often give the notes one or two octaves higher coincidently with their fundamental. For this reason and for its convenient duration of vibration I prefer the  $A = 213$  d. v. s., of medium size, more often found in the shops, or one flattened to the even 200. Such a fork, struck upon some rather soft surface by falling its own length, should generally be heard some ninety seconds through the air when held before the ear; while with its handle resting upon the mastoid or other portion of the skull or face, it should be audible slightly less than half as long. It should be heard equally in each ear from points in the middle line of the head; and the sound-waves should escape from each canal, as can be heard through the auscultation-tube. Stopping the canal with the finger should increase the sound in the closed ear to a degree that extinguishes its perception in the other and makes the sound again audible by bone-conduction after it has been normally lost. Low tones are heard relatively better by bone; high tones, by air: so high-pitched forks should have long handles if their use on the mastoid is to be free from probable fallacy. Low-toned forks should be lightly struck to test bone-conduction, lest their vibration on the head should be oppressively loud.

If we place the vibrating A-fork on one mastoid it should be heard for some forty seconds, as stated, and for some fifty more when transferred to the front of the canal; and each other fork has its fairly definite proportion for a normal ear, equal on

the two sides. But in deaf ears the finding will be different and discrepant perhaps on the two sides. Lesion of the conducting-apparatus will impede alike the entrance of sound-waves by air and their escape from the tympanum when awakened there through bone-conduction. Hearing by air-conduction will be subnormal, by bone-conduction it will be exaggerated; the proportion changing from 90:40 to perhaps 30:50, bone-conduction preponderating. This is Rinné's or Schwabach's test,—modified by Roosa very practically by merely noting whether it is "louder front or back," as almost any patient can rightly decide.

If the deafness be due to the pericipient apparatus, the normal preponderance of air-conduction will continue, bone-conduction being relatively worse, or, perhaps, totally lost. The proportion may now be A. C. 40: B. C. 10. So, too, from the middle line of the head the hearing will be worse in the worse internal ear, whereas if the trouble be in the conducting-apparatus the more obstructed ear will be the one hearing louder by bone-conduction. This is Weber's test.

Gardiner Brown modified Weber's test by resting the tuning-fork on the bridge of the nose and having the patient raise his finger just when he ceased to hear its vibration. As this should be exactly when the vibrations ceased to be felt by the fingers of the examiner, a rough, but practical, measure is gained (for each ear if unequal) of the increase or decrease of the bone-conduction, and the result is conveniently stated as + 3", — 4", etc.

Cases will frequently be met where

these tests give uncertain or contradictory results. Patients will give their preconceptions instead of observing the actual perceptions, unwilling to say that they hear by bone louder in the ear which they know to be worse, or confusing palpable vibrations with their weakened auditory perceptions. A deaf-mute will often claim to hear the fork as well resting on the patella as when on the mastoid. Yet a little patience and variation of the tests will generally clear up contradictions. The high tones are later and in less degree lost in tympanic affections, unless thickening of the drumhead shut out some such sound as the impure tone of the watch-tick.

**BARANY TESTS.**—In lesions of the static labyrinth—*i.e.*, the semicircular canals and vestibule—we are indebted especially to Bárány for a series of valuable tests, involving generally the production of nystagmus. This rhythmic motion of the eyes is seen often as the mere oscillation of eyes with imperfect fixation or in the strained eyes of miners, but is then made up of to-and-fro excursions of equal rapidity, little influenced by the direction of the gaze. In the nystagmus here considered there is a slow movement of the eyes to one side, due to stimulus from the opposite labyrinth or cerebellum, followed by a quick (cerebral) movement of readjustment. As this is often not exactly in the horizontal plane, it is called a "rhythmic rotary nystagmus." Although the significant phase is really the slow movement, which in some cases especially of cerebellar disease is a fixed conjugate deviation, the quick component has attracted more notice and the

nystagmus has been named "to the left" if the quick motion is to that direction. Normal eyes will often show it slightly if turned to the extreme position of lateral rotation: it is merely the wavering of the overtaxed abduction. Such motion is slight and equal on the two sides. In labyrinthine cases it is unequal: rotation of the eyes to the affected side usually exaggerates the quick motion; the nystagmus lessens or may wholly cease on looking to the opposite side. Such conjugate deviations of the eyes were ascribed by Högye to preponderant stimulation of the cerebellar-vestibular center of the side opposite and may be due to hyperactivity of this center or reduction of function of that on the other side. Ewald showed that endolymph flow toward the ampullar end is stimulant in the horizontal external canal, depressant or inhibitory in the superior vertical canal. It may be easiest to remember that "stimulant flow is *up* in the *upper* canal."

It is requisite, then, to have some means that can stimulate one labyrinth at a time, in order to test the functional competency of each. The most natural stimulant of this sort is rotation, to which the nystagmic movement of the eyes is a physiological reaction. If the patient be seated in a revolving-chair and turned steadily to the right ten times, for instance, there is created a current in his right horizontal canal toward the vestibule and away from it in the left. Such a flow is stimulant on the right, sedative on the left; the eyes tend to move slowly to the left with quick, nystagmic jerking toward the right. But this is hard to observe in the revolving patient. Stop the rotation

of the chair and the patient and study his eyes; we can now note the nystagmus ascribable to the continued movement of the endolymph in his ampullæ. Just as a matchstick floating on the water in a tumbler is unmoved by quick rotations of the vessel to and fro, because inertia holds the supporting fluid unmoved; but is carried round by steadier rotation when friction on the sides has imparted rotation to the water, and continues to revolve after the glass has ceased to move; so this **after-turning nystagmus** supplants the other and persists for some thirty seconds equally on the two sides if there is no difference in the excitability of the two labyrinths. The actual flow of the viscid endolymph in the capillary semicircular canal must be small, but this persistence is evidence for its reality; and the suggestion has been made that there are more hair-cells on one aspect of the crista ampullaris, on the proximal side in the superior, on the distal side in the horizontal canal, to account for the unequal stimulation caused by the direction of the flow. If we time, best by using a stop-watch and with the eyes cut off from fixation by opaque glasses, the duration of the nystagmus first to the one side and then to the other, we have a fairly practical measure of the relative excitability of the two labyrinths. By bending the head forward or back so as to bring the superior canals into the horizontal plane of rotation, we can submit them to a like testing: yet full differentiation is difficult, and not only is vertical nystagmus probably always a compound movement in the component direction caused by both superior and posterior canals, but

even the rotary element of the horizontal nystagmus shows that the rotation is not precisely in the plane of the approximately horizontal semi-circular canals.

A similar measure for testing one labyrinth at a time is furnished by the "caloric test" of syringing one ear with water colder or warmer than the body temperature. This depends upon the law of convection of heat by fluids, in that injection of hot water causes a flow upward in that canal which the pose of the head brings into the vertical plane; cold water causes the reverse effect. The pressure of the fluid, which can cause vertigo and nystagmus, is, to be avoided by steady gentleness. Cold water, *i.e.*, of about 70° F., is more commonly used, as it causes more prompt but fleeting reaction; if the head be erect it should give flow down toward the ampulla in the superior canal. This is the direction of inhibition for this canal, giving preponderance to the opposite labyrinth and a slow movement of the eyes toward the syringed side with quick movement to the opposite—"nystagmus away from the syringed ear." With the head thrown back the same effect should be produced; if bowed forward, the reverse. Vertigo is apt to follow too prolonged a test. No nystagmus will result if the cold fails to reach the labyrinth because of pathological obstruction, or finds it unresponsive through destroyed function: the test can be made in a doubtful case after the tympanum has been eviscerated, with the patient still under ether.

Galvanism is likewise able to stimulate the labyrinth upon which the cathode is acting, so the inefficiency

or overaction of 4 to 5 milliampères can furnish information as to its function, although some slight effect may be ascribable to the vestibular nerve-trunk, even after the labyrinth has been destroyed.

A fourth test is known as the "fistula test," since it is apt to evoke nystagmus in response to pneumatic pressure or suction exerted upon a labyrinth abnormally open toward the external canal, as by a fistula in its wall. Suction should cause a slow movement of conjugate deviation toward the open horizontal canal; pressure, a deviation away from it. The reverse effect is to be expected if the action is on a fistula in the superior canal; less definite results if the opening be about the oval window: nystagmic response would at least indicate a functioning labyrinth on that side. Mere vertigo is sometimes extreme in cases with lax annular ligament or other undue mobility of the fenestra, even though the ear has never suffered a suppurative lesion—pressure and suction seeming to have the same effect.

In any of these tests the nystagmus, when marked, may be easily recognized, even under the closed lids, and its duration timed by the watch. Slight oscillation may require that the patient's eyes be excluded from fixation by opaque spectacles, be turned to the side of the rapid component, and light reflected upon the globe under the uplifted lid. When no spontaneous nystagmus exists, we time its duration from its inception to its disappearance; when it pre-exists, we try to measure the duration of the exaggeration.

The catarrhally deaf usually hear relatively or even actually better in

a noise,—“paracusis Willisii”; whereas those with nerve-deafness are made worse by it. Very high tones, such as given by the Koenig rods or the Galton whistle, may be inaudible to a diseased labyrinth or portions of the gamut may be lost, while all voice-tones, as well as much deeper notes, are normally heard. Yet in these cases, while all the vowel-sounds may be heard, however pitched, there is a loss of consonants, whose subtle variations and slight energy make weak impression on the impaired percipient mechanism: “the sound but not the sense” will be gained. Add the confusion of coincidental noises, as in general conversation, and those so affected may be wholly disabled; and the uncomprehended jargon of voices becomes almost maddening. These limitations must be learned and borne in mind; then the tuning-fork tests will generally be found to lead to correct diagnosis; and the many instances of mixed affection will be noted, as well as those which are totally differentiated.

Diagnosed in the manner outlined above there will be a small, but important, group in which there has been a small-cell infiltration of the labyrinth as the result of syphilis, acquired or inherited or of cerebro-spinal meningitis, or typhoid, or other fevers. The onset of the deafness may be sudden, usually without vertigo, or it may be stealthy and gradual. Acoustic hyperesthesia may precede it, and the condition may be very unequal on the two sides. In children, who are its more frequent victims, it is generally only noted that they do not hear or that they are not talking as they should. Convul-

sions without defined or protracted illness may be reported as the starting-point, or trauma with loss of consciousness. The deafness following mumps may belong in this category, but generally seems rather a toxemic acoustic paralysis.

### SYPHILIS.

The stigmata of inherited syphilis are to be sought in the typical facies, with its exaggerated nasolabial lines; the high-vaulted palate; wide-spaced and pegged incisor teeth, only sometimes notched; the clouded corneæ, or nodes upon the shin or other bones. The family history, with miscarriages and early deaths or typical lesions in other members, may be our only evidence.

**TREATMENT.**—Whether syphilitic or not, the same treatment is indicated. Absorption of the infiltration by the **antisyphilitic drugs** constitutes our main resort. In recent specific cases Politzer’s vigorous use of **pilocarpine** has given excellent results in some cases; but the treatment cannot always be borne, is inconvenient with its sweatings, and can hardly equal for the ear or for the general condition the usual anti-syphilitic medication. Long-standing cases offer little prospect of benefit, but they have been known to gain beyond all expectation, and the underlying disease may in itself demand this treatment. Salvarsan has been charged with precipitating if not causing injury to the acoustic nerve.

### LABYRINTHINE EFFUSION (MENIERE’S DISEASE).

Another notable group includes the cases of labyrinthine effusion causing vertigo and deafness, generally associated with Ménière’s name.

"The Ménière complex of symptoms" is now generally spoken of, and some writers have not only differentiated tympanic vertigoes, but have inclined to deny the reality of "Ménière's disease." Yet, clear-cut cases of this affection do undoubtedly occur, and the influenza epidemics caused not a few of them. The seizure is usually apoplectiform, with intense vertigo, not infrequently with severe nausea and marked tinnitus and deafness. Some cases note the dizziness only on rising, but others are almost as distressed by it while at absolute rest in bed. Whether the acoustic or the co-ordination areas of the labyrinth are the seat of the lesion, both functions are at first profoundly affected; but the mere serous effusions can probably be absorbed completely, leaving no loss of hearing. As the labyrinthine vertigo is usually an *irritative* lesion, disappearing equally whether resolution or destruction be the result, it is possible that all of the profound affections are exudative or hemorrhagic. Some cases of typical labyrinthine apoplexy recover almost completely, but with a permanent gap at some part of the auditory scale.

In the vasomotor type of aural vertigo, where the fleeting character of the symptoms forbids any assumption of extravasation or sometimes even of serous effusion, great benefit is frequently gained from **adrenal therapy**. The desiccated gland in 2- or 3- grain (0.13 to 0.2 Gm.) dose several times a day can greatly steady the circulation, as can **strychnine** and other tonics. As an emergency dose **adrenalin chloride**,  $\frac{1}{100}$  grain (0.00065 Gm.), can be carried in the pocket and kept at the bedside, for it is often

on attempting to rise in the morning that the patient suffers the vertiginous attack.

**LABYRINTHITIS.**—Suppuration and necrosis of the labyrinth have been increasingly recognized by the symptoms in late years, but especially have been found unheralded after radical opening of the diseased middle ear. Necrotic areas or fistulous openings of its outer wall, most often on the convexity of the external or horizontal semicircular canal where its protrusion narrows the junction of attic and antrum, have been recognized and surgically dealt with. Removal of the dead bone opens the canal and for a while disablingly drains off the perilymph; yet healing can take place with preservation of function if the lesion be circumscribed. In the more extensive lesions there is generally loss of hearing as well as of equilibrium. Spontaneous nystagmus, vertigo, and impaired muscle-sense may wholly disable the sufferer; but often the process is more insidious. Tests of the static labyrinth may at first show undue and perverted irritability; later there will be no reaction on the affected side. The patient has to learn anew to balance himself, making fullest use of sight and muscle-sense in the effort, unstable as a three-legged stool that is poised on two legs. Darkness or closed eyes, even a sudden upward glance, may deprive him of visual compensation,—an unexpected slope of his standing ground may disconcert it,—while a dive into water may so rob him of the help of gravitation as to make him quite unable to come again to the surface. The dangers in his avocation may call for intervention to remove limited lesions or fully



destroy the diseased labyrinth, aside from the prognostic indication that many of the cerebellar abscesses and meningitis attacks are due to labyrinthine suppuration. The tympanum must first be eviscerated to give access; then we can open the ampullæ above the facial canal, the posterior canal behind it, or the region of the oval window below it—by any of these routes entering and curetting the vestibule. It has been found not generally needful to destroy each ampulla—this quickly follows destruction of the vestibule; but all carious bone should be removed. Tinnitus, vertigo, and other symptoms have often been most successfully relieved as a prompt result, and in skilled hands the mortality, although notable, has not been high.

**TREATMENT.**—Total rest in bed, derivatives, and perhaps bloodletting should be first tried, followed by absorbent alteratives. Charcot's use of heroic doses of quinine should be a last resort, as a means to complete the destruction of tissues incapable of resolution.

The effect of quinine, salicylic acid, and other drugs upon the labyrinth is often misunderstood. They certainly cause hyperemia in physiological dose; but probably here, as elsewhere, in toxic doses produce profound ischemia, such as is seen in the eye in quinine-blindness. Diseased ears are apt to be especially susceptible to the tinnitus and other discomforts of these drugs; but it is an open question whether they are more prone to be injured by them than normal. Malarial affections may leave marked or total deafness when no quinine has been given; and many a case has unjustly drawn

blame upon the physician because he has given quinine when his only error, if any, has been in giving too little. Just as in the tympanic inflammations, stasis must be overcome at times; and quinine is often our best, if not the most comfortable, means to this end. As the prejudice against it is widespread, however, great caution must be employed in its use; even those with anemic tinnitus, who find prompt relief from its exhibition, showing sometimes the greatest reluctance to taking it.

Akin, perhaps, to these cases are the losses of hearing following mumps, diphtheria, and other acute affections. They can, perhaps, be best compared to the blindness following ptomaine poisoning from sausage and such foods. There is certainly microbic invasion of the labyrinth in some of the diphtheritic cases; but these are apt to show the more usual septic inflammatory reactions. Acoustic atrophy, like that of the optic nerve, generally calls for an alterative course to limit and repair, if possible, the ulterior lesion, followed by vigorous strychnine stimulation.

### OCCUPATION-DEAFNESS.

Finally, the matter of "occupation-deafness" demands our consideration, since it offers a valuable field for prophylaxis. "Boilermakers' deafness" is met among workmen in many trades where noise is great and continuous; but the riveter inside a boiler is naturally the most prone to suffer with the effects of such concussion upon his acoustic apparatus. Tampons have been employed with slight palliative effect; but the sufferer had best change his work to a

safer one. Tympanic affection may be coincidentally active and demand appropriate treatment, but should not blind us to the deeper condition. The rapid-fire automatic gun is likely to claim many victims in this way, just as the dentist's electric hammer paralyzed the nerve-supply of many teeth before its dangers were recognized. So, too, the various methods of persistent pneumatic or phonomassage have wrought much damage.

### TINNITUS.

Tinnitus is a symptom rather than an affection, as to which much remains to be learned. Where it is high pitched and of long standing little expectation of its disappearance should be raised; but it ought to be generally possible to reduce it to a mild annoyance. It is at times strictly cerebral; may be due to turbinal pressure in the nose; but is generally of tympanic origin and can be benefited by treatment of the coincidental deafness. Yet it may have no relation to any defect of hearing, occurring when it is unthreatened or persisting after it has been restored. General vascular conditions must be looked to in the blowing type of noises, and **dietetic** rather than medicinal measures resorted to. **Pneumatic massage**, most easily employed with the finger-tip, will often do much for its relief.

While anode closure is the more usually helpful, cathode opening may in certain cases prove more efficient in reducing or silencing tinnitus. Most otologists have abandoned electricity as less valuable than their more usual methods.

In early life, and occasionally later, peripheral irritation is the direct cause of tinnitus, *e.g.*, acute obstruction of

the pharyngeal end of the Eustachian tube the result of colds; occasionally it is kept up by a more or less chronic stricture of the tube. The writer has relieved such tinnitus by injecting into the inner end of the Eustachian tube a minute quantity of **glycerite of phenol**, not exceeding 1 minim (0.06 c.c.) at the outside, and introduced very gently, otherwise much evil may result. When stopped thus, tinnitus is arrested instantly. In the tinnitus occurring later in life, with fixation of the stapes, **dilute hydrobromic acid**, 1 dram (4 c.c.) 3 times a day, may act well where the blood-pressure is high. **Zinc valerate**, 5 to 7 grains (0.3 to 0.45 Gm.), should also be tried. In the minority of cases in which the blood-pressure is normal or low, **digitalis** and **strychnine** should be given along with the hydrobromic acid. The author has seen tinnitus due to an adhesion of the tympanic membrane and the stapes head, which was relieved by **division** of the tiny **adhesion**. In pulsatory tinnitus, resulting from perception of the heart sounds as conveyed by the column of blood, relief is usually not very difficult to obtain with **digitalis**, **strophanthus** and **hydrobromic acid**. R. Lake (Lancet, May 30, 1925).

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### INTERTRIGO, ERYTHEMA INTERTRIGO, OR CHAFING.—

**DEFINITION.**—An hyperemic affection of the skin characterized by an erythematous condition produced upon contiguous surfaces, accompanied with an exudation of sweat with maceration of the skin.

**SYMPTOMS.**—Intertrigo is produced through closeness of contact between two apposing surfaces. The juxtaposition may cause irritation whether assisted or not by friction. It is an affection of hot weather, but may also occur in the winter. Heat acting directly on the subject and thus indirectly upon contiguous areas assists in its production and extension. It occurs in regions such as the nates, groins, axillæ, the spaces between and beneath the

breasts in the female or in corpulent males, as well as overlapping portions of the abdomen, the sulci of fingers and toes, and, in fact, any redundant portion of skin.

At first there is only an erythematous blush, but this soon increases in degree and in extent. Prolonged contiguity may lead to a true traumatic erythema, which with the retained sweat causes maceration of the adjacent portions of skin. If allowed to continue, the maceration may extend and end in a true inflammatory process.

In infants intertrigo is apt to be an annoying affection. Eczema is likely to supervene if no attention be given. The rubbing is also encountered after horse-back riding, rubbing of tight-fitting boots or clothes, etc.

The parts are hot and tender, if not actually painful. In an unattended case bleeding may occur as a result of fissures and removal of the upper layers of the epidermis. The parts emit a disagreeable odor, and, according to Crocker, of London, stain—but do not stiffen—linen: a point which this author adduces as of diagnostic value between eczema and intertrigo.

**DIAGNOSIS.**—The diagnosis of this condition is not difficult. The fact that there are two apposing surfaces in which there is a retention of sweat, emitting a disagreeable odor, and causing maceration and fissuring of these surfaces, should be sufficient in most cases. Removal of the cause is generally followed by an early cessation of the symptoms. Eczema will persist for shorter or longer periods, according to the extent of surface involved, and not alone will remain in position, but will also increase, if not judiciously treated. In the latter affection there is some degree of infiltration and thickening, which does not occur in erythema intertrigo unless eczema complicates the process. Congenital syphilis may also be confounded with this affection, but the fact that syphilis extends far beyond the borders of the contiguous surfaces will generally suffice to prevent error. Syphilis also produces a darker discoloration. An "erythème syphilitiforme" is noted by A. Fournier, which begins as a papulovesicle and resembles the vaccine papule; but as

these lesions are to be found in repeated succession, error is hardly possible.

**ETIOLOGY.**—The causes of intertrigo are manifold. Warm weather or heat produced by artificial means during the winter season may act as an inducing factor. Exaggerated exercise, rowing, running, horse-back riding, as well as sedentary habits as observed in clerks who sit for long periods who wear unsuitable undergarments, and sweating at contiguous points are known causes. Friction, with or without moisture, will induce it. Secretions—such as saliva (the cases, for instance, following repeated protrusion of the tongue and licking the parts), vaginal discharges, unre-moved feces during the existence of a diarrhea, the dribbling of urine, and the complication of glycosuria—are as many etiological factors. Many other conditions contribute to assist in its production and extension, such as the milk upon garments of careless mothers, which, thus being allowed to dry, roughens and stiffens the dressings, so that rubbing is soon induced. In young infants improperly washed diapers are also causative media.

**TREATMENT.**—As a rule, little or no treatment is required. Removal of the cause will usually end in early recovery. Inattention to the parts may allow the case to proceed to a high grade of inflammation. The first indication is to remove, by means of some bland soap—Castile or glycerin soap—and water, the foreign elements acting as irritating factors, and immediately afterward dry with a soft towel. An odor may require the addition of a slight quantity of carbolic acid or thymol.

Bland dusting powders are very useful; but if allowed to remain and absorb the discharges they induce an aggravation. Boric acid, talc, fullers' earth, lycopodium, or starch in impalpable powder relieves both pain and irritation.

Schamberg recommends in simple cases:

*R Magnesiæ carbon.,*

*Talci venet.,*

*Zinci oxidi* .... ãã 3ij (8 Gm.). M.

Or, the following lotion:—

*R Resorcini,*

*Acidi borici,*

*Glycerini* ..... ãã 3j (4 Gm.).

*Zinci oxidi* ..... 3ij (8 Gm.).

*Aquæ* ..... q. s. ad f3j (30 c.c.). M.

Solutions are often more grateful, but must be applied almost continuously to obtain good effects. Boric acid in saturated solution is one of the best agents. **Sulphite** and **hyposulphite of sodium** in water in the strength of from  $\frac{1}{2}$  to 1 dram (2 to 4 Gm.) to the ounce (30 c.c.) are often beneficial. Astringent washes give excellent results. **Acetate of lead** (3 to 5 grains—0.2 to 0.3 Gm.—to the ounce—30 c.c.—of water), **sulphate of zinc** (1—0.065 Gm.—or more grains to the ounce of water), **acetate of zinc** (in similar proportions), **bichloride of mercury** (1 to 2 grains—0.065 to 0.13 Gm.—to 1000 parts of water), **calomel** (3 to 5 grains—0.2 to 0.3 Gm.—to the ounce of lime-water—*lotio nigra*) are all efficacious. A useful method is to apply one of the above lotions for a period of fifteen minutes; then to thoroughly dry the parts by mopping them, and to follow this by one of the dusting powders. This should be carried out three or more times during each of the twenty-four hours. In addition to the remedial measures the parts must be kept apart by means of medicated lint or cotton: a procedure which suffices in some of the cases observed. In obstinate cases it may be advisable to place the patient in bed for this purpose.

The treatment of inguinal intertrigo is purely local. Acute cases must be treated like an eczema. Where the surface is inflamed and the epidermis moist and sore, it is best to apply a weak solution of **silver nitrate** of  $3\frac{1}{2}$  per cent. strength; or, if a stronger solution is indicated, one of 10 per cent., the strength being determined by the sensitiveness of the tissues. A very moist, oozing intertrigo is treated each day with a lotion composed of:—

℞ *Argenti nitratis* . . . 3j (4 Gm.).  
*Aqua dest.* . . . f3iij (90 c.c.). M.

The use of **ichthyol** is indicated where the oozing is not excessive and the lesion is red and but slightly moist:—

℞ *Ichthyolis* . . . . . f3j (4 c.c.).  
*Resorcinolis* . . . . . gr. xv (1 Gm.).  
*Aqua dest.* . . . . . f3iij (90 c.c.).  
 M.

A stronger solution contains double the quantities of **ichthyol** and **resorcin**. These topical applications are best made with a pledget of absorbent cotton. Sabouraud (*La Clinique*, Jan. 22, 1909).

The prophylaxis of this affection consists in keeping the skinfolds scrupulously clean and in the local use of alcohol or of iodized or camphorated alcohol.

Where the affection is established, free use of **soap** and **water** is helpful but the region must be very carefully dried. A better plan is to cleanse with **alcohol** or **spirit of camphor** 3 times daily. Once a day an application of the following may be substituted for the alcohol washing:—

℞ *Tinctura iodi* . . . . . 3ss (2 c.c.).  
*Alcoholis* . . . . . 3ij (8 c.c.).

M.

Only in rebellious cases may the pure tincture be applied, and this only once, or, at least, only after an interval of 4 or 5 days. After each alcohol ablution, the area should be dusted over generously with sterile **talcum powder**. **Wads of cotton** may also be used to keep the adjacent surfaces apart.

In obstinate cases the area may be painted every 4 days with a solution of silver nitrate on absorbent cotton, after carefully freeing the surface of fatty material:—

℞ *Argenti nitratis* . . . . . 3ss (2 Gm.).  
*Aqua destillata* . . . . . 3x (40 Gm.).

Solve.

Afterward, a zinc rod of metallic zinc should be passed over the skin, precipitating the silver on the affected area. Finally either talcum powder or the following zinc paste is applied:—

℞ *Zinci oxidi*,  
*Petrolati*,  
*Adipis lanae hy-*  
*droxi* . . . . . āā 3ss (15 Gm.).

M. et ft. unguentum.

Millian (*Paris méd.*, April 19, 1913).

In intertrigo the result of acute enterocolitis in infants, Fischer advises the fol-

lowing: Stop milk and give rice, arrow-root or albumin water, with plenty of pure water for thirst. Give **sodium phosphate**, 5 to 10 grains (0.3 to 0.6 Gm.) every morning for 2 or 3 days, usually followed by **castor oil**, 1 dram (4 c.c.). Soak the parts with **oatmeal water**. Give an **oatmeal hip bath** (soaking bag of it in tub of boiling water for  $\frac{1}{2}$  hour, then allowing to cool to 100° F.). Then: **Calamine** and **zinc oxide**, of each, 3 parts; **petrolatum**, 50—used 3 times daily, after cleansing with olive oil, if necessary. Dust with cornstarch or wheat flour.

**Methenamine** used in 30 infants suffering from intertrigo (gluteal erythema and eczemas), recovery being obtained in 3 or 4 days without local measures. The urine and feces of infants thus treated did not have an ammoniacal odor. This confirms Cook's view that the condition is due to an ammoniacal fermentation of the urine. The doses used were 0.1 to 0.2 Gm. ( $1\frac{1}{2}$  to 3 grains) 3 times a day in young infants and light cases, and up to 0.25 Gm. (4 grains) 4 times a day for older infants or when the lesions were pronounced. Simchen (*Arch. f. Kind.*, Dec. 18, 1923). C.

## INTESTINAL PARASITES.

See PARASITES, DISEASES DUE TO.

**INTESTINES, DISEASES OF THE.—NORMAL AND PATHOLOGICAL PHYSIOLOGY.**—The modern conception of intestinal disorders is so closely bound up with the physiology of the diseased structures that a review of the latter subject is necessary.

It has been well said that we eat with our small intestine and drink with the large. As a result of various factors, foodstuffs are completely disintegrated in the small bowel, and by a process of selective absorption are then taken up by the lacteals. The acid chyme, passing from the stomach into the duodenum, remains

acid until such time as it is neutralized by the intestinal juices, including pancreatic and biliary secretions. According to Cannon, the acid juice of the gastric side of the pylorus, when reaching a certain degree of acidity, acts reflexly, resulting in opening the pylorus, while on the duodenal side its action is the antithesis of this. Further, this acid chyme, by combination with the cells of the duodenal mucosa which contain prosecretin, results in the development of a substance called secretin, which, acting as a hormone, has been shown to be the most powerful excitator of pancreatic juice. This activation, as it is called, of prosecretin cannot be the sole factor in exciting the stimulation of pancreatic juice, because the latter is present even when hydrochloric acid is absent.

Bile, on the other hand, is secreted more or less constantly, but especially during the taking of food and for some time subsequently, during digestion. Toward the end of this period, bile regurgitates into the gall-bladder, probably because of the reflex contraction of the sphincter-like end of the common bile-duct. During intestinal digestion especially, bile is discharged into the duodenum, particularly under the influence of proteins and fats. When these gain entrance into the duodenum, perhaps reflexly or possibly by some hormone action, the gall-bladder contracts and the sphincter of the common duct relaxes. Bile was at one time supposed to be antiseptic, but this view is no longer held, for clinically we know the frequency with which the gall-bladder becomes infected in typhoid and other intestinal and general diseases. Bile, too, furnishes an

excellent culture medium. It serves both as an excretion and a secretion. In its excretory function, it aids in carrying away some of the by-products arising in the chemical processes of digestion, while as a secretion it aids in breaking up fats, helping to render them more amenable to absorption. This well-known fact is borne out clinically by the great increase of fat in the feces when for any reason bile is absent. Formerly thought to stimulate peristalsis, it is now known that the chief stimulant to peristalsis occurs purely as a result of taking food, or even the thought of food, when one is hungry, will cause increased peristalsis. As has been stated, with the pancreatic juice it aids in alkalizing the acid chyme.

The pancreatic juice is by far the most important of all of the secretions concerned in the process of digestion, for it contains all of the essentials, only awaiting activation of trypsinogen in order to be able to digest all of the food substances. The enzymes of the pancreatic juice are trypsinogen, amyllopsin, and steapsin. The first of these, trypsinogen, is activated by a secretion of the intestinal mucosa known as enterokinase, trypsin, a proteolytic ferment, resulting. Amylopsin converts starches into sugars, while steapsin is a fat-splitting enzyme. Deficient or absent pancreatic juice also causes the appearance of large amounts of fat in the bowel, allows putrefaction of proteins and fermentation of the carbohydrates, large, pale, pasty, offensive stools resulting. Less is known about the succus entericus in a definite manner, but, apart from the actions already given above, it is

probable that many endogenous enzymes exist, acting only or chiefly within the cells. One of these, also a proteolytic enzyme, is known as crepsin, while another, nuclease, is said to act upon nucleins, while still another, invertase, converts saccharides of more complex forms into simpler ones.

In addition, a certain amount of watery content, epithelial cells, gases, and bacteria are present in the bowel. The large bowel exerts itself chiefly in the direction of absorbing water, which diminishes from about 90 per cent. in the bowel contents at the ileocecal region, to about 75 per cent. in the stools. Some slight absorptive power must exist in the first portion of the large bowel, because small quantities of protein, fats, and sugars may be recovered from the cecum, these being absent from the feces. As the bowel contents move along and absorption of the fluids takes place, they gradually assume a firmer consistency; and except in old people or in some abnormal conditions, only assume form from the position of the splenic flexure downward. Naturally, anything which causes retention for a greater period than normal will result in more or less hardening and scybalous transformation of the contents. Micro-organisms constitute a considerable bulk of the dejecta, the vast majority of which are probably dead at the time of their ejection. According to Strashburger, about one-third of the weight of dried feces consists of bacteria.

X-ray studies have shown that it requires about four and one-half hours for food to traverse the small bowel, which in an adult of average height is about  $22\frac{1}{2}$  feet in length,

or at the rate of about 1 inch per minute. In addition to active peristalsis, by which means the food is passed along the bowel, a process of segmentation goes on in the small bowel, evidently designed to expose a greater area of contents to absorption, and at the same time to effect more perfect mixture. From four to four and one-half hours after a meal, food begins to pass into the cecum. Peristalsis is much less active in the large bowel and diminishes progressively along the course of the colon. It has been estimated by Hertz that it requires approximately two hours for food to reach the hepatic flexure and two and one-half hours to reach the splenic flexure and two hours more to reach the commencement of the iliac colon. It may here be stated that the accepted anatomical nomenclature today places the termination of the descending colon at the brim of the pelvis, the iliac colon from the brim of the pelvis to the inner border of the psoas muscle, and the pelvic colon from this latter point to its junction with the rectum at the angulation opposite the third sacral segment. With this in mind, one may better understand Hertz's statement that the rate of passage through the iliac colon is about equal to that through the preceding portions of the colon, but that through the pelvic colon (formerly known as the sigmoid or omega loop) the rate is much slower, and that normally nothing enters the rectum until the stimulus to defecation is received.

It is probable that segmentation, as it is known in the small intestine, never occurs in the large, and anything approaching to the peristaltic movement of the small bowel never

occurs in the large. It is possible that the waves are too small to be perceptible on a fluoroscopic screen.

A point of interest and value in diagnosis is the relation between gastric and intestinal sounds, which occur normally and are more or less rhythmical and musical than the sounds heard over the ileocecal valve. This valve, or the valve of Bauhin, like the internal rectal sphincter, is formed by an increase of the muscular coat of the bowel. The transverse layer of the ileum is more or less thickened at its point of entrance into the colon and constitutes the ileocecal valve. It is kept in a state of moderate tonic contraction through impulses conveyed by the splanchnics. Hence, stimulation of these nerves, as in appendicitis or peritoneal inflammation, causes firm contraction of the sphincter, and at the same time inhibits movements of the intestines in a more or less widespread manner.

The bowel contents are thus prevented from passing into the cecum; all cecal sounds cease if the process be a local one, as in appendicitis, and with general inhibition, as in diffuse peritonitis, all sounds may be observed to cease.

It is to be noted, however, that the contractibility of the gastrointestinal musculature is not solely under the control of the cerebrospinal and autonomic nervous system, for, like the heart muscle, a certain amount of automatic rhythmical movement is possible, as shown in excised portions. It is probable that these motor functions, independent of the central nervous system, are to be attributed to the nerve cells constituting the plexus of Auerbach. Normally, stim-

ulation of the vagi causes contraction of the stomach and bowel muscles, except those of the colon, these latter being under the control of the pelvic nerves, coming from the sacral cord.

### INTESTINAL NEUROSES.

It has been previously stated that the gastrointestinal functions are excited both psychically and by the taking of food, and abnormally too; disturbance of functions may result in consequence of various psychic factors as well as from improper foods or beverages, or excessive amounts of these. Consequently, various intestinal symptoms may in all justification be ascribed to functional neuroses, or to reflex disturbances from near or remote points, and it is believed that even changes in the amount or quality of the various enzymes and even their suppression may result from psychic factors. Intestinal neuroses may be grouped under three subdivisions: (a) Motor. (b) Sensory. (c) Secretory.

#### A. MOTOR DISTURBANCES.

—As we have seen, active peristalsis is practically limited to the small bowel, and, therefore, since this is supplied by the vagus, increased motility presupposes vagal irritation from some source, while the converse of this, namely, deficient motility, is the result of splanchnic irritation. By motor disorders of the bowel we imply, therefore, functional disturbances solely concerning the vagus.

Increased motor activity is termed peristaltic unrest, and, while it frequently results from the presence of irritants of various kinds, it is often due to psychic disturbances, as in nervous, hysterical, emotional, or hy-

pochondriacal states. In their mildest form, borborygmi constitute the chief evidence, which in the hysterical, as is well known, may be loud enough to be heard many feet from the patient, and often associated with contractions of the abdominal muscles, rhythmical in character. Pain is the exception in this state. Eructations, sometimes explosive, and even violent, may be associated. When still more marked, pain may result, tormina, in consequence of the peristalsis which in thin individuals may be observed through the abdominal wall.

**Nervous diarrhea** is a combination of peristaltic unrest plus an increased transudation of fluid into the bowel. Either one of these factors may predominate, so that in some instances the condition is painful, while in others watery diarrhea is the chief factor, without pain. This is sometimes spoken of as a diarrhea of relaxation. Mental disturbances, such as worry, shock, fright, or emotional states of various kinds, not rare in students before examination periods, when the vesical sphincter is also subject to relaxation, are illustrations of its possible psychic types, as are those cases dependent upon fancied or real genitourinary conditions. The taking of hot or cold beverages may also act as a stimulant, with the production of diarrhea shortly after the beverage is taken; as an evidence of motor disturbance of organic origin may be cited locomotor ataxia or transverse myelitis or a meningo-myelitis. This possibility necessarily depends upon the site of the lesion, and, as a rule, retention prevails, though in other instances involuntary diarrhea may be the conse-



quence. In the purely functional states loose stools vary from one to many, consisting of watery material, not unduly offensive, usually without evidence of mucus, rather serous in fact, with more or less gurgling sound.

**Intestinal Spasm.**—This has already been touched upon in speaking of peristaltic unrest. In its milder forms diarrhea is the rule; but in lead poisoning, enterospasm and constipation are associated. In cerebral meningitis associated with a gradually developing scaphoid abdomen diarrhea may first appear and obstinate constipation later. It is never a very marked manifestation in the purely functional conditions.

**Intestinal Paralysis.**—As was stated under the physiological heading, this frequently occurs as a result of splanchnic irritation, in which case the ileocecal valve contracts, while the intestinal movements are inhibited. This accounts for the quiescent state of the stomach and small bowel during abdominal operations, exposure to air resulting in temporary inhibition. It may also occur after operations during which the viscera have been freely handled. In some measure this inhibition of movement is beneficent, for when perforation occurs inhibition lessens to some extent the spread of peritoneal contamination. The colon is supplied by the pelvic nerves and is not associated with the sympathetics. Any condition lowering the general neuromuscular tone, as in disorders of the brain or cord, typhoid states, on the one hand, or focal lesions on the other, may result in muscular paresis of any portion of the bowel, including the rectal sphincters, so that event-

ually involuntary discharges may occur.

**TREATMENT.**—The treatment of motor neuroses will depend, of course, on the causative factors and on the extent of the symptoms. In the milder psychic cases isolation is not necessary, but it is certainly an indispensable adjunct in the more marked types, and is sometimes imperative in cases of actual mental derangement. Great caution should be exercised in the employment of narcotics in any of these conditions, for the habit is readily established.

Since insomnia is so frequently associated with nervous conditions, attention to this detail is indicated, for its persistence aggravates the nervous symptoms, which in turn aggravate the insomnia. Hot baths at bedtime, or preferably 5 grains (0.3 Gm.) of **Dover's powder**, followed by a **cabinet sweat bath** and after the cabinet sweat a **sponge with warm water and soap**, will often effectually obtain an unbroken rest, and at the same time relieve the diarrhea. In cases associated with muscular spasm, **atropine**, **belladonna**, and **hyoscyamus** are of value rather than morphine and eserine salicylate in the atonic cases. Occasionally in the most marked spastic cases, **opium** in some form may be necessary to relieve the spasm and constipation attendant upon it.

**B. SENSORY DISORDERS.**—Some of these have already been touched upon, since they are the inevitable result of the more marked types of motor disturbances. The intestine and its peritoneum are devoid of ordinary nerves of sensation. It is possible that they possess some protopathic sensory function, but even

this is not certain. Mackenzie seems to have shown that pain emanating from intestinal disturbances is really referred to the abdominal wall, and that it represents a visceromotor reflex originating in stimulation of the autonomic fibers. Neither handling, cutting, nor burning of the intestine experimentally seems capable of exciting pain sense, but distention or obstruction, either of which interferes with the normal passage of the peristaltic waves; these seem to be the only stimuli capable of awakening pain not only in the case of the intestine, but also of the other hollow muscular viscera, as the stomach, ureter, renal pelvis, bile-ducts, etc.

Intestinal pain or *enterodynia*, therefore, always follows distention produced either by gaseous decomposition and accumulations within the lumen or from some form of obstruction to the peristaltic wave. When this becomes still more marked and paroxysmal, we speak of it as *colic*. As we have seen, the splanchnics preside over the bowel in a peculiar manner, bringing about inhibition of the general bowel wall, except the colon, with closure of the ileocecal valve. Many of the stimuli, therefore, emanating from within the bowel are probably not felt because of this influence, the irritation not having been sufficient to excite visceromotor reflexes. We have also shown that peritonitis, too, may be limited by these means. Painful stimuli do not arise in peritonitis, unless the parietes are involved and then only because of the distribution of visceromotor nerves in the peritoneal tissue.

**TREATMENT.**—In the functional sensory disturbances relief is often

obtained by local application to the abdominal wall, thereby obtunding visceromotor reflexes, excited through spinal irritation carried from the bowel afferently by the splanchnics. These with the employment of some carminative, such as chloroform, 2 drops; spirit of camphor and Hoffmann's anodyne, of each,  $\frac{1}{2}$  dram (2 c.c.), together with some mild laxative. Fright, fear, excitement, or, in short, any psychic disturbance must necessarily be dealt with according to its merits.

### C. SECRETORY DISORDERS.—

It seems probable, in view of the watery diarrhea that follows psychic disturbances, with or without evidence of sensory disturbances, that in some instances these are due solely to the emotions. It is probable that normally a stimulus results with the production of sufficient fluidity to prevent the stools from becoming scybalous, or, because of neglect, obtunding of the parts and prolonged contact with the mucosa result in abnormal drying of the contents. The only two conditions which with any degree of justification can be looked upon as functional disorders of a secretory character are, first, serous diarrhea, and, second, mucous colitis. With the former of these we have already dealt.

### MUCOUS COLITIS.

**SYNONYMS.**—Mucous colic, tubular diarrhea, mucomembranous colitis, and myxoneurosis intestinalis.

**DEFINITION.**—In the strict sense in which the terms mucous colitis or membranous colitis are employed here, we are dealing essentially with one of the secretory neuroses of the colon, characterized by more or less

frequent stools, often very painful, containing tough mucus in shreds and masses and occasionally tubular structures composed of epithelial cells of mucosa, together with more or less mucus. In some, constipation alternating with diarrhea exists.

**SYMPTOMS.**—The vast majority of patients presenting this condition are women, and they range themselves into two groups: first, those of a more or less chronic dyspeptic and melancholic type, not seldom of constipated habit, and the other, high-strung, active, extremely nervous, intensive and often imaginative individuals who most commonly suffer with diarrhea. The former, and less frequently the latter, group may also have visceroptosis, though this is not an essential part of the picture. As a rule, the sufferers from this condition are usually somewhat ill nourished, though occasionally one meets with a well-developed woman, especially, in whom, following some domestic or other trouble, the condition develops. The dyspeptic type of cases are those, as a rule, who quarrel with their food, so to speak, finding fault with one article of diet after another, until after a process of elimination they virtually starve themselves; in consequence of this their nutrition suffers, they lose weight, complain of the cold, are subject to chilly sensations, and insist on wearing a great deal of clothing. More or less anemia is the rule. Though constipation prevails in this type, an occasional attack of diarrhea may ensue without apparent cause, and the breath is often somewhat offensive, mouth rather dry, tongue coated, and after some special nervous strain quantities of mucus will be passed, less frequently of the

tubular variety than is the case with the irritable, high-strung type. So, too, with vesical symptoms.

In the melancholic type frequency of micturition and more or less dysuria are rather uncommon. From time to time, they suffer attacks of abdominal pain, colicky, griping in character, often with tenesmus with some meteorism and tenderness on pressure, over the outer part of both iliac regions especially. Nausea and vomiting are uncommon. Though the mental depression is almost constant, the abdominal symptoms are intermittent, and some time may elapse without definite evidence of a mucous colitis, when rather suddenly, following colic, masses of glairy mucus and even pseudomembranous material may be passed. Internal hemorrhoids not seldom occur in these individuals, and in such instances large amounts of blood may be lost, rendering the patient more or less acutely anemic. Such cases, in the absence of the colitis stage, usually have hard, scybalous movements, or both this and the passage of jelly-like mucus. Owing to the severity of the tenesmus in some instances syncope attacks may occur during the attempt at defecation. Digital examination of the rectum and even the use of a proctoscope or sigmoidoscope may reveal nothing abnormal, or at most some hemorrhoids. It seems as though cycles existed during which volumes of mucus are poured out, and this passes almost immediately.

The more actively high strung, neurotic type presents a somewhat different aspect, often voluble, readily subject to irritation and often proving very irritating in social relations

with others, verbose and frequently quarrelsome, often of a subtle and suspicious type, harboring real or imaginary grievances and not seldom possessed of sexual neuroses. In this type the dyspeptic symptoms are not marked. The appetite is often good, sometimes even large, but capricious.

Diarrhea is the prevailing feature, and as many as 15 or 20 stools a day may be suffered without evidence of more prostration than would follow but 2 or 3 movements. Tormina and tenesmus are often very marked, bloody mucus is not uncommon, and in the case of internal hemorrhoids the passage of large quantities of blood. The most striking feature, in this type especially, is the passage of membranes or skins, as they are often termed by patients, which may be pale or more or less brown, as a result of staining by bowel contents. In the most marked cases it forms a complete cast, tubular in shape and varying in length from one to several inches, rarely longer. They may be very thin, and their true shape only discovered by floating out, preferably in salt solution, or very thick and tough. Either with this, or more frequently without, pieces and shreds of all shapes and sizes may be voided, or ball-like masses held together by glairy mucus may be passed. Teased out under the microscope, they are found for the most part to be structureless, though containing fragments of more or less digested material, micro-organisms, phosphates, and occasionally cholesterin crystals. Here and there columnar epithelial cells may be seen, or long, continuous shreds of epithelium, often very well preserved, constitute the bulk of the cast.

Except for the conditions stated, the general body functions may be apparently normal, at least as far as any physical examination or laboratory test is able to reveal. If psycho-analytic methods be employed, it will often be discovered that these individuals have a mental bias dependent upon some worry or trouble connected with their daily life. It is probably safe to assert that fully one-half of the women have some diseased condition of the uterus, tubes, or ovaries, or that the sex relation is of an abnormal or depressive type.

[I know of one instance in which the dread of pregnancy became a monomania, and this woman had a most marked mucous-membranous colitis with 15 to 20 stools daily, often exquisitely painful, associated with internal hemorrhoids and the loss of much blood. Clamp and cautery operation, done by Dr. Lewis H. Adler, had no other effect than causing a cessation of the bleeding. She had suffered a number of miscarriages, some doubtless induced, and on account of the intense suffering at the menstrual periods, together with the reflex pains at other times, ovaries and tubes were removed by Dr. Duncan. For some time subsequently the mucous colitis ceased, but recurred later. Without local manifestations, certainly without evidence of appendicitis, I suggested an appendectomy and the performance of an appendicostomy with subsequent irrigation of the colon. This was done by Dr. Wayne Babcock almost three years ago, since which time the patient has gained a great deal of weight and has been absolutely symptom-free as far as the colon is concerned. W. EGBERT ROBERTSON.]

Membranous dysmenorrhea is said to occur in a small proportion of these cases, but such a case has never come under my personal observation. Intestinal sand, too, of the true variety is not infrequent in this type of patient, which consists chiefly of phosphate and oxalate of calcium

with iron and magnesium with biliary coloring matter. These are usually the more severe types.

[Another case under my observation, one of the depressive type, developed after the advent of infelicity, following a childless union. Dilatation and curettage, and abdominal section with resection of the ovaries, failed to have any influence upon the condition. The woman markedly improved, however, after separation was effected and she devoted herself to social service work. R.]

Close resemblance of mucous colitis to pellagra pointed out. The symptoms are both nervous—headache, insomnia and various delusions—and gastrointestinal, the latter more marked after taking food. Constipation is usually present, gas often disturbing, abdominal pain more or less constant, and mucus usually noticed, especially after a purge. L. G. Neal (Jour. Med. Assoc., Ga., May, 1924).

A man aged 42, after alcoholic excess, complained of epigastric discomfort and after 2 days, of discomfort in the cecum. There was obstipation. Four days after onset he had severe pain in the region of the descending colon. Proctoscopy showed a mass in the sigmoid resembling a tapeworm. The cast was passed next day, with much blood and pain. It was over 35 inches long. C. Goldman (Med. Jour. and Rec., Dec. 16, 1925).

**DIAGNOSIS.**—Since mucous colitis and even the passage of pseudo-membranes may occur as a secondary process due to some organic factor, it is important to make a careful physical examination, including a painstaking digital examination of the rectum and a bimanual vaginal examination, and in competent hands, the use of the proctoscope and sigmoidoscope should be practised. The recognition of types in which this essential functional neurosis is most apt to occur is of extreme importance.

Care should be taken also to avoid mistaking vegetable cellulose, as when asparagus is eaten or the skins of sausage, for mucomembranous material.

Mucous colitis seldom exists alone, but is merely a local expression of a general catarrhal tendency involving all mucosæ, a polymyxoditis. There occur elevations of temperature which have a notable intermittent character at times, appearing as quotidian, tertian, quartan, or even with remissions of a week. As a rule, rigors and sweats do not occur, and the rise does not exceed 38° C. (100.4° F.). The condition persists until the colitis is cured. Couto (Deut. med. Woch., April 17, 1913).

During the last 5 years the writer has had under observation in hospitals and private practice 870 cases. He found the disease in 3 distinct groups: Simple mucous colitis, mucomembranous colitis, and muco-membranous colitis with visceroptosis. The first group is easily mastered; the 2 other groups are more resistant due to the severe accompanying disturbances. The affection is often mistaken for hysteria, neurasthenia, gastric neurosis, syphilis, ovarian or uterine disturbance, or movable kidney. Capparoni (Policlinico, Nov. 5, 1916).

**ETIOLOGY.**—Sex is the most important factor. It is usually stated that fully 80 per cent. of the cases occur in women, but I should be inclined to regard this as too low. I have never seen an authentic case in a male, though, of course, it is conceivable. Age, too, is important and likewise suggestive, for the majority of cases occur during the period of active sexual life, from 20 to 40, and are exceedingly rare after 50.

Mucomembranous colitis occurs four or five times more frequently in women than in men. It generally begins between the ages of 20 and 45, but the writer has seen it in a child

of 3, and in Goodhart's experience it is by no means uncommon in children, as he has several times seen perfect mucous casts of the intestines passed by them. A. F. Hertz (Clinical Jour., Aug. 3, 1910).

When an apparent case develops in one over 40, and even more so in later years, an organic cause should be sought for most carefully. Cases have been recorded in children, but they are open to suspicion, for it is questionable whether they are of the type comprised under the caption of myxoneurosis intestinalis. Neurotic and hysterical women or less often, women of the depressive, melancholic type, are those in whom it is mostly found. Foci of infection have been held responsible for it.

Stress laid on infection and incomplete elimination as combined factors in the etiology of mucous colitis. Among the local infectious foci, the teeth, nose, and throat should receive especial attention. Gall-bladder infections are by no means rare, and chronic appendicitis is the rule rather than the exception. No amount of dietetic or local medication will be of any value until the infection is located and removed. Stauffer (Jour. Amer. Med. Assoc., Nov. 27, 1920).

The writer recognizes a *chronic avitaminous colitis*, featured by attacks of mucous diarrhea several times a day and at night, with resulting emaciation. Recovery soon takes place upon addition of butter, eggs, fresh vegetables and fruit to the diet. H. Grundzach (Polska gaz. lek., May 11, 1924).

**PATHOLOGY.**—There is really no morbid picture. It is not an inflammatory disease, and no characteristic change occurs in the intestinal wall.

**PROGNOSIS.**—It is not a fatal disease, but frequently very persistent, many being absolutely rebellious

to all of the commonly employed plans of treatment. It often lasts for years and the more chronic the more rebellious.

**TREATMENT.**—A thorough study should be made of the patient as an individual. A searching inquiry should be made into the daily routine, and indeed into every phase of the patient's life, precisely as it is necessary in any case with a nervous substratum. Great care should be exercised in dealing with the patient in a kindly, forcible, but always consistent manner, and the avoidance of any semblance of morbid suggestion should be strictly adhered to, and especially an effort should be made to unravel the events immediately preceding the development of the condition. This may sometimes throw light upon the psychic side. In the intervals between the attacks the patient should be encouraged to live, as far as possible, a healthy and sane existence, indulging in fresh air, as much exercise as possible, and in an ample dietary.

The diet need not be restricted, even in an attack, though, of course, cellulose and all indigestible materials should be eliminated. Without especially seeming to do so, an attempt should be made to gratify the patient's appetite, avoiding an excess of sweets and any whims which may be manifested. Regular meals and plenty of rest should be obtained.

Von Noorden's treatment is essentially one of diet, but in place of the usual bland, unirritating diet with little residue, recommended by some, von Noorden advocates a coarse laxative diet, leaving as large a residue as possible. He prevents the usual irritating effect of such a diet by add-

ing to it large quantities of fat in various forms.

The most important element in his diet is cellulose, obtained from vegetables and the husks of various leguminous plants. The cellulose undergoes bacterial decomposition in the intestine, and so gradually that the binding together of the feces into solid, hard lumps is prevented.

The patient should go to bed and stay there. A rubber hot-water bottle is to be placed on the abdomen whenever there is distention or pain, and at night an enema of 6 to 10 ounces (180 to 300 c.c.) of olive oil at a temperature of 98° F. (36.7° C.) is given slowly from a douche-can with a long, soft-rubber nozzle (8 inches), preferably in the genupectoral position, or on the back with raised hips.

A suppository of belladonna extract (gr. ss—0.03 Gm.) or of morphine, if the pain is severe, should be inserted, and the patient directed to retain the oil until morning. It may be necessary to continue the oil injection and belladonna suppository for several days. Ransome (Liverpool Medico-Chir. Jour., July, 1908).

Two cases of obstinate mucous colitis, rebellious to all known treatments, which responded promptly to the oral use of charcoal, given 4 times daily, after meals, in doses of 8 Gm. (2 drams) suspended in water, or enclosed in cachets. T. B. Broadway (Lancet, May 4, 1918).

Five main factors stressed in the treatment of mucous colitis: (1) Removal or correction of focal infections; (2) a diet balanced in proximate food principles and vitamins, especially vitamin C; (3) free mechanical drainage of the colon by introduction of fluid into the rectum, whence it can be caused to travel to the rectum by reverse peristalsis; (4) acidophilization of the intestinal tract by ingestion and rectal implantation of viable strains; (5) autogenous vaccines. Ingestion of lactose, dextrin, fruit and vegetable residue will promote the growth of the aciduric type of bacteria. Benefit has followed the use of

a combination of castor oil, menthol and iodine in keratin-coated capsules. N. P. Norman (Amer. Jour. of Electr. and Radiol., Apr., 1923).

Favorable results reported from treatment with an autogenous vaccine prepared with cultures from the patient's stools. Knorr (Wien. klin. Woch., Apr. 3, 1925).

Insomnia, not an uncommon feature of this disease, requires very careful handling. The possible acquisition of the drug habit can be readily foreseen. Where possible, change of scene is often beneficent, and if their interest in any legitimate occupation can be encouraged, the battle is often half-won.

Calumba-agar, containing solid constituents of 2 c.c. (32 minims) of fl. ext. calumba in 1 Gm. (15 grains) of agar, found useful in mucous colitis. Einhorn (Amer. Jour. Med. Sci., Feb., 1912).

To overcome accumulation of mucus, a weekly purge and colonic irrigations every day or two for a week are indicated. Twelve to 24 quarts of hot tap water or sodium bicarbonate, 1 dram (4 Gm.) to the pint (475 c.c.), should be used, the patient lying on the left side for the first gallon, then on the back. Irrigation is a failure if no water is retained to be evacuated after the irrigation has been finished, or if it returns clear throughout. A diet of bran, fruits, and coarse vegetables is useful, but at first may do more harm than a mild tonic laxative. The best laxatives are liquid petrolatum, cascara-agar, phenolphthalein-agar, milk of magnesia, or salts. Compound licorice powder is of benefit. Occasionally of value is retention of 4 to 16 ounces (120 to 475 c.c.) of olive oil or cottonseed oil in the rectum over night. Water should be drunk freely. If there is ptosis, support is needed. In the treatment of attacks of colic, atropine sulphate, 0.001 Gm. ( $\frac{1}{100}$  grain), is the best of the drugs for pain and neurotic symptoms. A large dose of bromide, 2 to

4 Gm. (30 to 60 grains), **codeine phosphate**, 0.03 Gm. ( $\frac{1}{2}$  grain), and **hot applications** are also useful. The patient should **rest in bed**. For the evacuation of mucus at the time of the attack, **castor oil** by mouth, **codeine** and **atropine** hypodermically, and **colon irrigation** will often give relief. Bastedo (Jour. Amer. Med. Assoc., Jan. 24, 1920).

The patient should be warned that 6 to 12 months, or even longer, will be required for a cure. The **diet** at first should consist of milk, cheese, eggs, gelatin, butter, fresh figs, and small amounts of bread, preferably graham. Later, the bulky vegetables and meat are gradually added. **Exercise** and **rest** should be carefully regulated. Of drugs, the best are **arsenic** and **belladonna**, the former as **sodium cacodylate** given intravenously to tolerance, and the latter as the tincture, in 3 drop doses after meals until physiologic effects come on. Pain referred to hyperacidity is generally controlled by **sodium bicarbonate**, 30 grains (2 Gm.), and **bismuth subnitrate**, 1 dram (4 Gm.), after meals. If there is hypoacidity, **hydrochloric acid** should be prescribed. Gas may be reduced by **charcoal**, 10 to 20 grains (0.6 to 1.2 Gm.) every 3 hours. **Magnesium citrate** is serviceable for constipation not controlled by diet if hyperacidity exists; otherwise **castor oil** should be used. Benefit attends occasional **colonic irrigations**. L. G. Neal (Jour. Med. Assoc., Ga., May, 1924).

All sorts of enemas have been employed, with about an equal degree of failure. Not seldom they result in a degree of local irritation which positively contraindicates them.

Treatment by **irrigation** of the **colon**, as carried out at Plombières and Harrowgate, gives excellent results. It consists of irrigation of the bowel by a hydrostatic douche, given through a long tube passed into the sigmoid. Twenty to 40 ounces of **alkaline sulphur water** at a low pressure are used. After the internal

douche follows a warm immersion **bath** or **sulphur water**, a hot douche playing upon the wall of the abdomen from a large nozzle with small perforations directed over the site of the colon. Attention, on the patient's part, to **moderate exercise**, **warm clothing**, the use of a **hot bottle** to the **cold extremities**, and avoidance of exposure to undue cold will give the greatest comfort. Mantle (Brit. Med. Jour., July 11, 1908).

In **lavage** through the **appendix** normal **saline solution** or a 5 per cent. **glucose** should be used, as the least irritating of lotions. In some cases if  $1\frac{1}{2}$  (750 c.c.) or even 2 pints (1000 c.c.) of saline are passed through the appendix it works along the bowel and distends the sigmoid, but it is not expelled spontaneously. Sometimes gentle massage over the colon leads to its expulsion. If not, it may be necessary to use astringents—**hazeline**, **zinc sulphate**, a few drops of **formalin**, or the smallest quantity of **silver nitrate**.

Hawkins and Mummery both use **olive oil** to remove the mucus. The writer prefers **liquid petrolatum** rectally. Daniel (Proctol., Mar., 1912).

The writer employs pills of **dry pancreatic extract** and **sodium bicarbonate** (2 to 1), sometimes with **bile** as an excipient. Savini (Arch. mal. de l'app. dig.; Med. Record, Feb. 9, 1918).

Lubricants such as **liquid paraffin** are to be preferred for bowel activation in colitis. Locally, the author favors **soap-suds enemas** to soften the stools. For astringent purposes he prefers 10 per cent. **lime water enemas** to the irritating silver enemas. To soothe the intestinal wall, as well as to loosen the stools, he employs either **oil enemas** or an enema made up of finely powdered **metallic aluminum**, 2.5 Gm. (38 grains), and a 10 per cent. **decoction of salep**, 250 c.c. (8 ounces), with addition of a few drops of **opium tincture** if required. **Intestinal irrigations**, **spa treatments** and **mud** or **peat baths** are also of benefit. H. Strauss (Deut. med. Woch., Dec. 28, 1923).



In those instances in which a pelvic factor seems to be at work operative interference occasionally effects a cure, and in a goodly proportion of cases an **appendectomy** will be followed by a restoration of health, but I would advocate the more extensive employment of **appendicostomy** with subsequent **intestinal lavage** through the stump of the appendix, and after the recovery of the patient, which follows as a rule, it is not difficult to heal the minute sinus by the applications of a 33 $\frac{1}{3}$  per cent. solution of **zinc chloride**, using a very fine cotton applicator.

Report of 27 cases of mucous colitis cured by the operation of **lateral anastomosis of the ileum and the sigmoid**. All the cases were bad ones, and with few exceptions were poorly nourished, anemic subjects, often suffering from atonic dilatation of the stomach, achylia, pyloric insufficiency, enteroptosis, and various pelvic lesions. Of the 27 cases, 18 now have evacuations 1 to 3 times daily without laxatives. G. H. Noble (Amer. Jour. of Obst., March, 1910).

### INTESTINAL CATARRH.

**SYNONYMS**.—Intestinal inflammation; duodenitis, enteritis, colitis, proctitis, enterocolitis, according to the parts chiefly involved. The term diarrhea is also employed, as in the majority of instances this is the chief characteristic of the morbid condition.

**DEFINITION**.—Inflammation of the mucosa, hence catarrh, of any portion of the intestinal canal. It is not possible to recognize clinically the anatomical seat of the disease, with the possible exception of duodenitis or gastroduodenitis, as it usually is enteritis, colitis, and proctitis. Any part or all of the canal may be involved as an acute or chronic process, primary or secondary.

**SYMPTOMS**.—**Acute Form**.—In the simple acute form of catarrhal enteritis or diarrhea, mucoenteritis, colicky pain in the abdomen, and diarrhea are the chief features. Diarrhea may occur in the absence of intestinal inflammation as the result of nervous relaxation, a secretory neurosis, and, on the other hand, actual inflammation may exist without diarrhea, as in cases of duodenitis or jejunitis, but the association of both diarrhea and colicky pain bespeak an enteritis. If to the griping pain or tormina tenesmus be added, we are also dealing with a colitis or proctitis or both. The diarrhea is due to the inflammation of bacterial origin or, in part, to mechanical causes, as from improper foodstuffs and the resulting increased peristalsis.

The stools, at first fecal, dark in color, black or green, become lighter, even a dirty white, depending on the amount of biliary coloring matter. In consistence they vary from a watery to a gruel-like material, with flakes of mucus more or less incorporated when the small bowel is chiefly implicated. Microscopically they will be found to contain crystals—calcium oxalate and phosphate, Charcot-Leyden, and ammoniomagnesium—epithelial cells (columnar) and mucus, rarely cholesterolin plates and vast numbers of micro-organisms. A few red blood-cells may be found in the very severe forms and the occult reaction may be positive, even when no free red cells are observed. The other food remnants, present in greater or less numbers, plant cells, meat fibers, and starch, are usually alkaline in reaction.

Tympanites and borborygmi occur

whenever intestinal decomposition is going on. There may be very little tendency to an increased number of stools, or, again, there may be 10 to 20 in twenty-four hours. The lighter-colored stools are often very offensive. When vomiting occurs it is an acute symptom. Fever is slight and transient generally. The appetite is lost, the tongue coated and dry, and thirst is pronounced. Prostration is often disproportionate to the duration and apparent severity of the attack; it is probably toxic in origin, as are the headache, albuminuria, and body pains.

**Duodenitis.**—In this condition diarrhea is the exception, moderate constipation and jaundice being the dominant symptoms of a developed attack. In the earlier stages the symptoms are usually gastric, nausea and repeated vomiting, as a gastro-duodenitis is the morbid entity. In the absence of catarrhal swelling of the common duct and consequent jaundice, there is nothing diagnostic about the attack. A sense of epigastric distention, slight epigastric tenderness, a little quickening of the pulse rate, rarely an occasional cardiac arrhythmia, coated tongue, foul breath, and slight fever for a few days.

**Jejunitis and Ileitis.**—This is not to be separately diagnosed, but it may be suspected when the diarrhea (a common feature) is lenteric. Borborygmi, tympany, pain in the abdomen, especially in the region of the umbilicus, and undigested food particles in the stools, which in the absence of a duodenitis always contain bile and pigmented mucus, constitute the chief features. Colitis is very frequently associated with ileitis, and

tenesmus is apt to become the most marked and painful phenomenon.

**Colitis.**—Tenesmus and considerable glairy mucus with small and frequent stools and more or less constant desire to move the bowels constitute the important features of this state, and these are even more marked, the suffering being greater when the rectum is also involved. It is not unusual for an attack to begin in the small bowel, then involve the colon, and terminate as a proctitis which is often more lasting and rebellious to treatment. In colitis the tenderness is most marked down low in the abdomen, below the transverse umbilical line, and blood and mucus are frequently intermixed and grossly evident. The mucus increases in amount as the bowel is involved from above downward.

**Proctitis.**—Inflammation of the rectum. In this condition mucus or mucopus in large quantities is often passed without fecal material, and frequent calls to stool—almost constant, in fact—with distressing tenesmus constitute the diagnostic features. It must not be forgotten that this condition may be secondary to perirectal inflammation.

**Chronic Form.**—Chronic catarrh of the intestine is usually secondary to the acute or may occasionally arise without the preceding acute symptoms. It is the rule in portal congestion from any cause. The same features occur as were noted above, but pain is less, even absent in some cases. The most striking feature is the disturbance of nutrition due to the more or less prolonged course—loss of weight, anemia, and in many instances mental depression, low spirits, hypochondriasis, or melan-

cholia. Constipation alone or alternating with diarrhea, as a rule, and fermented, gaseous, offensive stools are to be noted. Fever is practically absent.

Chronic enteritis observed in 9 patients. The symptoms were intense intermittent colic, vomiting, and mucous stools; temperature and pulse usually normal; visible peristalsis above area of obstruction; progressive emaciation, with no improvement under expectant treatment. The abdomen was opened in each case and more or less bowel found similarly affected. Its surface was smooth and the walls rigid and thickened. Coliform bacilli were isolated from one specimen, but the others showed only the ordinary intestinal flora. T. U. Dalziel (Med. Rec., Aug. 16, 1913).

In the chronic enteritis of amebic cases there may occur, apart from functional disturbances of the colon, symptoms due to dragging on the abdominal sympathetic, in particular the filaments from the solar and celiac plexuses, through the mesentery. They consist of discomfort, weight, dragging, and squeezing, referred chiefly to the lower epigastric and paraumbilical regions. At times the discomfort amounts to actual pain, accompanied by a profound malaise which reacts heavily upon the mental equilibrium of the patients, generally deeply affected when the disturbance is of long standing and marked loss of weight has occurred. While aerophagia and the resulting dyspeptic disturbances are rather frequent, the stomach should not be held to account for the symptoms just referred to. E. Deglos (Paris méd., July 13, 1918).

**War Enteritis or Trench Diarrhea.**—As stated by Remlinger and Dumas (Rev. d'hygiène et de police sanitaire, Mar. 20, 1915), the term includes different conditions: Infections by typhoid and paratyphoid bacilli, muco-membranous enteritis, diarrhea connected with improper action of the stomach. In most cases it is

simply a more or less acute form of dysentery—a complaint from which no troops in the field are exempt. Diarrhea and dysentery have prevailed with particular severity among the troops in the Argonne. They appeared at the end of the hot weather, when hostilities began in that district, and were but little checked by the cold of winter. Of the several hundred cases, some were dyspeptics of long standing, others were cases of muco-membranous enteritis, easily produced by the coarse army diet, consisting largely of meat, independently of any stay in the trenches. Another was a case of paratyphoid.

Trench diarrhea, according to Remlinger and Dumas (*Ibid.*), has been attributed to cold and wet, and to the want of warm food. In the case of the large numbers of men unaccustomed to much meat, the fact that the rations consist almost exclusively of beef was certainly a contributory cause. Few of the patients attributed their malady to water. Although a few admitted they had drunk water from shell holes or from sources of doubtful purity, most of them said that the cold enabled them to a large extent to do without drinking anything but wine, tea, or coffee.

The authors look upon all these causes as predisposing only. The special bacillus seems, however, to have little effect alone, having been found in the feces of men who have not been exposed to the predisposing conditions, and who had remained in perfect health. The pathogenic bacilli seem to be derived from the trench mud contaminated with feces. This gets onto the boots, thence onto the hands and the food. In the summer dust and flies also transmit the infection. Even if the latter does not occur in the trenches, it may take place in the neighboring villages where the men go to rest, after 5 or 10 days in the trenches. The result is that these villages being crowded and deprived of proper sanitary precautions, even here the food may become contaminated.

**DIAGNOSIS.**—Attention to the degree of temperature, the presence or absence of jaundice, acute or chronic nature of the attack, frequency and character of stools as to food particles, mucus or mucopus.

and blood, tormina or tenesmus or both, and the degree of nutritional disturbances are the chief clinical features as outlined above.

From typhoid fever the diagnosis is to be made by the Widal and diazo reactions, and possibly by the leucocyte count and blood-culture. From dysentery, by the greater severity and usual acuteness of the illness and the bloody stools in that disease. In lead colic the occupation or other possible source of lead poisoning elicited in the history, the blue line on the gums, obstinate constipation, relief of pain by pressure and the basophilic red cells.

In amyloid disease of the bowel, evidence of chronic suppuration—tuberculous, as a rule—or of an old syphilis will serve to make recognition possible. Cholera morbus and intestinal ulcers are not likely to obtrude as diagnostic difficulties.

Coprologic evidences of colitis discussed. The best procedure for demonstrating intestinal *mucus* is to spread out the feces. Mucus, however, is much more rarely present macroscopically in colitis than is generally thought. It is well to prepare a dilution of feces in a mortar, pour it into a dish, and inspect for *brown, mucoid masses* of viscid consistency, which constitute a significant evidence of colitis.

*Albumins and albumoses* in the feces point to a severe exudative lesion of the bowel, and are readily tested for by precipitating 10 c.c. of a 5 to 2 per cent dilution of feces with 2 c.c. of saturated mercury bichloride solution. If the response is positive, the coagulated albumins fall to the bottom of the tube, with clear fluid remaining above.

*Diarrhea* is one of the most reliable signs of colitis, provided undigested cellulose, starch, iodophilic bacilli and bilirubin are *not* present in the stools. *Reduction of the organic acids* normally

present is another important sign, which may result either from alkaline hypersecretion or ammonial putrefaction in the right colon.

An excessive number of *spirilla* points to putrefaction, probably in the proximal colon. Large numbers of *Blastocystis hominis* or *Entamoeba coli* likewise point to colitis, as does also the presence of *starch residues* in stools of normal appearance. R. Goiffon (Presse méd., Apr. 26, 1924).

**ETIOLOGY.**—The various forms of intestinal catarrh may be due to primary or secondary causes. Primary—(a) Overeating. This is mechanical and excites peristalsis. (b) Improper foods. These may act as local irritants because of an idiosyncrasy or because of local irritations, as is the case when unripe fruits are eaten. (c) Toxic substances. When spoiled foodstuffs are ingested, usually milk, ice cream or meat, or certain of the inorganic poisons, as arsenic or mercury. (d) Weather conditions. The nature of which is unknown, though it is not unusual to observe a local outbreak of diarrheal disorders. In institutions these are not rarely due to one of the forms of the dysentery bacillus. A sudden change in the weather, or the heat of summer, is especially prone to invite the disease. (e) Impure drinking water or merely a change of water will sometimes induce an attack. (f) Nervous states will cause diarrhea in some individuals. (g) An excessive amount of bile may conceivably cause diarrhea by exciting peristalsis, but the recognition of such a case from the clinical standpoint would be speculative.

Report of an epidemic of mild diarrhea occurring in nearly every one of the 18 members composing a large household.

Investigation showed that for some time the meats and other food kept in the larder had been affected with a pinkish growth, which on examination was found to be the *Bacillus prodigiosus*. Parkes (Brit. Med. Jour., Nov. 18, 1905).

Many carefully conducted experiments have shown that the house-fly is capable of spreading certain pathogenic organisms. The especial organisms distributed are those producing the various types of bacillary enteritis.

The organisms of this category are also not infrequently found in the intestines of flies under natural conditions, but they do not in all probability remain in the fly for more than 1 or 2 days at the longest. William Nicoll (Brit. Med. Jour., June 30, 1917).

Attention called to the relationship of chronic colitis to endocrin disturbances. In some instances the endocrin disturbances are secondary, as in chronic bowel disease followed by pancreatitis.

In the course of 6 months the writer observed 9 cases of thyroid toxicosis secondary to postdysenteric colitis. In a second class of cases both the bowel and endocrin disturbances are due to a third condition, as in the gastrointestinal neuroses. Lastly, digestive disorders may be secondary to endocrin disease, as in the gastric secretory disturbances associated with exophthalmic goiter. Grote (Deut. med. Woch., Apr. 7, 1921).

As to the secondary causes, they are as follows: (a) Certain of the infectious diseases, as typhoid fever, advanced tuberculosis,—though the factor of ulceration may enter here or it may be a phase of elimination,—septic processes, dysentery and cholera, and cholera morbus. (b) Portal congestion, whether of cardiac, pulmonary, or hepatic origin, or due to multiple serositis. (c) Extension from contiguous inflammatory proc-

esses. (d) Terminal infections in Bright's disease, malignancy, or the profound anemias.

These secondary forms are essentially of the chronic types. As predisposing factors in any case are sudden atmospheric changes, or prolonged heat and drought, or local endemic influences the nature of which is not known. Children are particularly prone to diarrheal disorders (see DIARRHEAL DISEASES OF INFANTS, Vol. IV). Purgative medicines may set up an acute diarrheal condition which, under certain conditions, may continue for days.

**MORBID ANATOMY.**—The changes are not marked. It is seldom that one observes any injection of the bowels. The mucosa, in fact, is often pale, but in the acute cases it is swollen, though less than in the chronic form due to portal obstruction. The mucus is increased and often plaques the mucosa in foci more or less extensive. The *tops* of the valvuli conniventes are often injected in the upper part of the small intestine, and the Peyer patches and agminated glands are swollen and often the seat of small superficial ulcers or erosions—follicular enteritis. Sometimes the mucosa exfoliates in patches. In the more chronic forms the chief differences are that the mucus is less if the mucosa has suffered to any considerable extent, and, as stated, the wall of the bowel is often thickened, the result of secondary, proliferative, fibrous change.

**PROGNOSIS.**—The possibility of an acute condition becoming chronic must always be thought of, but, this aside, the acute forms usually terminate favorably in a few days. Any attack is a more or less serious

menace in one already debilitated, especially in children and the aged. In the chronic forms it rarely kills directly, though it may be a factor, especially in septic conditions. In the obstructed portal type the underlying cause will guide one in determining the probable outcome. In both breast and bottle-fed children, especially the latter and even strikingly in overfed children on the breast, a bronchitis or bronchopneumonia may terminate fatally a few days after the development of a diarrheal disorder.

**TREATMENT.**—In any condition associated with diarrhea the question of food is of paramount importance. In the acute forms it is advisable to **withhold all food for twenty-four to forty-eight hours**, allowing only **pure water** by mouth. A single dose of **castor oil** or a few fractional doses of **calomel** given at short intervals, followed by a **saline**, may be the only medicine required.

For the pain, a few drops of **laudanum**, or if nausea and vomiting be annoying features, a hypodermic of **morphine**, gr.  $\frac{1}{4}$  (0.016 Gm.), and **atropine**, gr.  $\frac{1}{150}$  (0.0004 Gm.) to an adult, may be required. **Rest in bed** is always advisable, as the attack will be terminated more quickly. **Albumin water, carbonated water, Célestin Vichy**; as to **diet**, rice, arrowroot, cornstarch, or predigested milk are permissible in most cases. Eggs are badly borne by some. Raw or stewed oysters and fish may be given during convalescence and baked potatoes at almost any stage. When the large bowel is involved **enemas** are of special value. Preferably there should be given an initial **saline** followed by **starch water**, 4 to 6 ounces

(120 to 180 c.c.), containing 15 to 20 drops of **laudanum**; this, however, is only to be used in adults. Proctitis in children is often abruptly terminated by wiping out the lower portion of the rectum with **silver nitrate**, 60 grains (4 Gm.) to the ounce (30 c.c.) of distilled water, using a cotton applicator. This procedure is painful, but the result justifies its employment. **Sinapisms** often afford relief, as do **turpentine stupes**. In the chronic forms, in addition to the above, **enemas** should be resorted to daily, **saline** or **starch water** and **castor oil** given every day or two by mouth, and the following also administered internally:—

R *Phenolis* ..... gr. L (3.24 Gm.).  
*Bismuthi subnitrat.* ʒss (15 Gm.).  
*Tinct. opii camphorata* ..... fʒj (30 c.c.).  
*Syr. zingiberis* ..... fʒij (60 c.c.).  
*Aqua cinnamomi*,  
q. s. ad ..... fʒiv (120 c.c.).

M. Sig.: Two fluidrams (8 c.c.) in water every two hours for adults.

There are no intestinal antiseptics in the strict sense, so that one must depend on the occasional sweeping of the entire tract by means of **castor oil**, employing an **enema** after the oil has proven effectual, in the hope that **lavage** may finally remove the offending factor; or **creolin**, fʒj (4 c.c.) to a quart (1000 c.c.) of water, or a 1 or 2 per cent. solution of **quinine and urea hydrochloride** may prove of service. These are best given high and at body temperature, using a fountain syringe and rectal or colonic tube, and having the patient on the back or right side, with the head low and the hips elevated.

In enteritis, especially tuberculous, the author praises highly the action of **methylene blue**. The formula is:

Methylene blue, 0.05 Gm. ( $\frac{3}{4}$  grain); sugar of milk, 0.2 Gm. (3 grains). One such pill three or four times daily. After three days the diarrhea will generally cease. M. Perrote (Thèse de Paris, No. 228, 1904).

In certain cases fluid gelatin acts very satisfactorily. A 10 per cent. solution in distilled water is boiled for six hours and then filtered, and the resulting fluid keeps clear and fluid for days. A soup made of calves' feet (about 1 pound to 1 quart of water, boiled down to 1 pint) is useful in diarrheal conditions in children and in typhoid fever. Mann and Herzberg (Ther. der Gegenw., xlv, Nu. 11, 1905).

**Cooked starch** used to check diarrhea; sipped from time to time by the teaspoonful. Found especially useful in the diarrhea of consumptives. Hauffe (Ther. der Gegenw., xlv, Nu. 12, 1906).

**High injections of hot Carlsbad water** are valuable in chronic intestinal catarrh after failure of ordinary measures. L. von Aldor (Deut. med. Woch., Jan. 9, 1908).

In acute gastroenteritis, including severe cases of fish poisoning, **kaolin** treatment found highly successful. The kaolin is stirred up with water and drunk while in suspension; 200 Gm. ( $6\frac{3}{4}$  ounces) of the clay can be mixed with  $\frac{1}{4}$  liter ( $\frac{1}{2}$  pint) of water. One drink usually stopped the diarrhea. Vomiting also ceased at once. In mild acute gastric catarrhs the measure was successful in 27 cases out of 30. In gastrointestinal catarrh of infants the results were good in early cases. Infants were given from 10 Gm. to 25 Gm. ( $2\frac{1}{2}$  to  $6\frac{1}{4}$  drams), while older children received 50 Gm. ( $1\frac{3}{4}$  ounces). No addition of milk or sugar can be made. In influenza with diarrhea, kaolin also yielded good results. In some cases injection of 100 Gm. ( $3\frac{1}{4}$  ounces) into the rectum stopped the diarrhea rapidly. In intestinal tuberculosis the author was also able to arrest the diarrhea. J. Goerner (Münch. med. Woch.; Brit. Med. Jour., April 18, 1908).

Diarrhea is often due to abnormal secretion in the intestine of a fluid which putrefies easily. **Hydrogen dioxide** is the most efficient intestinal disinfectant. Pure agar-agar takes up from 10 to 12 per cent. hydrogen dioxide and yields it up slowly, this combination supplying nascent oxygen in the intestine. It was used in diarrhea with serous foul-smelling stools, with good results. A. Schmidt (Med. Klinik, March 28, 1909).

The first addition to the **milk diet** should be toast, eggs, and raw, scraped or chopped beef, or, if such uncooked meat is very disagreeable, the chopped beef may be slightly broiled. **Bismuth**, if used, should not be continued for more than a week without intermission. **Phenyl salicylate** may be given with benefit in doses of 0.3 Gm. (5 grains), three or four times a day, combined with the bismuth if desired. It should not be continued more than a week.

In some instances **sodium bicarbonate** seems valuable—0.5 Gm. ( $7\frac{1}{2}$  grains) three times a day. Organic combinations of **tannic acid** are most valuable as astringents. **Quinine** seems often to inhibit looseness of the bowels. The dose should be fair sized, but not enough to cause disagreeable head symptoms. **Ferrous sulphate**, in capsule, in a dose of 0.2 to 0.25 Gm. (3 to 4 grains), three times a day after meals, is frequently indicated. A. D. Blackader (Amer. Jour. Med. Sci., Oct., 1909).

In the treatment of trichocephalus enteritis **thymol** in 1-Gm. (15 grains) doses should be given in a cachet 3 or 4 times a day for 3 or 4 days, followed by a **saline purge**. No wine, alcohol, or oil to be taken. Cade and Garin (Brit. Med. Jour., March 25, 1911).

Many cases of diarrhea are due to increased irritability of the stomach, the contact of food with the gastric mucosa reflexly exciting intestinal peristalsis. To diminish irritability the following mixture is recommended:—

**R.** *Cocaine hydrochloride*,  
*Codeine phosphate*,  
of each ..... gr. xlv (3 Gm.).  
*Peppermint water*.. ʒiii¼ (100 c.c.).  
**M.**

The dose for adults is 10 drops, ten minutes before meals. E. Fuld (*Semaine méd.*, Aug. 28, 1912).

**Agar** medicated with astringents found useful where intestinal mucosa inflamed or ulcerated. **Gambir-agar**, containing solid constituents of 2 c.c. (32 minims) of tr. gambir comp. in 1 Gm. (15 grains) of agar; **tannin-agar**, 0.03 Gm. (½ grain) of tannin to 1 Gm. (15 grains); **simaruba-agar**, 1 c.c. (16 minims) of tincture to 1 Gm. (15 grains); **myrtle-agar**, 1 c.c. (16 minims) of tincture to 1 Gm. (15 grains), recommended, the last especially in diabetic cases. Einhorn (*Amer. Jour. Med. Sci.*, Feb., 1912).

In chronic diarrhea **raw fruits with milk** often brought about better results than a milk diet alone. With a combination of lukewarm milk with **strawberries** pressed through a sieve—1 part of juice to 3 of milk—the author had very good results. Besides the mixture he allowed only crackers and two eggs daily. C. Wegele (*Med. Klinik*, June 1, 1913).

Long-standing chronic diarrhea often yields to **rest in bed**. The effects of purgation in acute and benign cases are familiar, and **castor oil** or **magnesium sulphate** seem secondary only to **rest in bed**. In acute cases **starvation with catharsis** is the ideal treatment. **Warm normal saline solution irrigations** seem to be of value in some obstinate cases and **olive oil** is useful in long-standing cases. **Psychic influences** are also mentioned as successful when other methods fail. Large doses of **bismuth** are sometimes useful. R. C. Cabot and Haven Emerson (*Jour. Amer. Med. Assoc.*, Sept. 27, 1913).

In 256 cases of acute colon bacillus enteritis in soldiers in the trenches, often with 6 to 30 movements a day, and blood in 51 per cent. of cases,

the writer found the best treatment to be daily ingestion of 1 to 2 liters (quarts) of a mixture of 1 part of **condensed milk** with 4 of **rice water**. **Opiates** may be added for colic, and **calomel** and **lactic ferments** for malodorous stools. Lassablière (*Bull. de l'Acad. de méd.*, Mar. 7, 1916).

In diarrhea due to an unknown intestinal infection, the writers use **chloramine T**, which sets free alkaline hypochlorites upon slow decomposition. They prescribe daily 4 capsules or tablets, each containing 0.05 Gm. (¾ grain) of chloramine with 0.3 Gm. (5 grains) of **powdered charcoal** or **powdered agar**. In chronic enteritis with persistent diarrhea, Depist and Durand recommend **zinc oxide**, which precipitates mucin and serum albumin, 0.6 to 1 Gm. (10 to 15 grains) a day in keratin-coated pills each containing 0.2 Gm. (3 grains), at regular intervals between meals for 2-week periods, with intervening intermissions. Carnot and Bondony (*Médecine*, July, 1920).

**Basic aluminum salicylate** recommended. It is a white or pinkish powder, insoluble, decomposed in the intestine into the gelatinous aluminum hydroxide, which is absorbent, prevents inflammatory reaction to irritants, and delays the passage of fecal material. The giving of 2 to 4 tablets of 0.5 Gm. (7½ grains) each daily cured all cases of simple diarrhea in 2 or 3 days. Good results also in diarrhea in infants resistant to diet, in chronic enteritis, and in diarrhea of early tuberculous cases. Rochas (*Progrès méd.*, Mar. 18, 1922).

A **turpentine** treatment for diarrhea cured 90 per cent. of all diarrheas of bacterial origin as well as all cases due to trichomoniasis. On the first 3 days the patient is given every 2 hours a spoonful of a mixture of 150 Gm. (5 fluidounces) of acacia solution and 12 Gm. (3 fluidrams) of **paregoric** with 2 to 4 Gm. (½ to 1 fluidram) of **oil of turpentine**. An evacuating **enema** of 1 or 2 liters (quarts) of a decoction of **gambir** or **eucalyptus** is taken morning and evening and fol-



lowed by an enema to be retained, consisting of 4 spoonfuls of boiled water containing 1 yolk of egg beaten up with 20 to 40 drops of oil of turpentine and 10 to 25 drops of tincture of opium. Food allowed: Only a glass of boiled fresh milk with 4 spoonfuls of lime water and a little potato or gruel every 3 hours, followed by a tablet of **pancreatin** and **sodium bicarbonate**, of each 0.2 Gm. (3 grains); **pepsin**, 0.4 Gm. (6 grains), and **diastase**, 0.1 Gm. (1½ grains). Rice water used as beverage, and hot applications made every 3 hours to the abdomen, meantime kept covered with flannel. Rest to be ordered. Escomel (Cron. med., Mar., 1923).

In catarrhal diarrheas **calcium** is superior to all other remedies. The writer uses **calcium carbonate**, preferably with an equal amount of **calcium phosphate**, 1 teaspoonful 3 times daily. Among the diarrheas thus benefited are those of exophthalmic goiter and sprue, the gastrogenous diarrhea of achylia, and the gastroenteritis of children. A suitable diet should be prescribed, and in diarrhea of pancreatic origin **pancreatic ferments** should be added. I. Boas (Deut. med. Woch., Oct. 31, 1924).

### PHLEGMONOUS ENTERITIS.

This is practically a complicating process secondary to strangulated hernia, chronic obstruction, or intussusception. Rarely, from some unknown cause, it may occur as an apparently primary process in the duodenum. It is conceivable, too, that it may occur in septic conditions. It is a purulent infiltration of the intestinal submucosa, diffuse or localized, and the localized form consists essentially of multiple abscesses. Symptomatically, it mimics peritonitis, and except in those conditions in which it is known to occur as a concomitant, viz., strangulated hernia and intussusception, one cannot diagnose it. The only treatment is surgical in

those conditions in which the primary factor is known.

### CROUPOUS OR DIPHTHERIAL ENTERITIS.

**DEFINITION.**—An intense inflammation of the mucosa of the entire intestinal tract, with more or less necrosis and pseudomembranous formation.

**SYMPTOMS.**—Briefly, purging, blood-stained mucous stools, tormina, tenesmus, shreds of mucus in the stools, often vomiting and fever and profound prostration characterize the condition. Frequently it is masked by the underlying causal condition. Occasionally there are no characteristic features, and the disturbance may be discovered only at the necropsy.

**ETIOLOGY.**—The disease is always a secondary process. Occasionally it arises in the course of some of the infectious diseases, as sepsis, typhoid fever, pneumonia, occasionally in leukemia, and as an end-process in malignant diseases, especially those involving the bowel. It may also occur in intestinal hepatic cirrhosis or chronic Bright's disease, and occasionally as a result of mercurial or arsenical poisoning. In the former, a polypoid colitis and ulcerative lesions are very apt to be associated.

In the milder types of the disease a dirty, grayish exudate on a more or less congested base may alone be noted, merely upon the tops of the intestinal folds. This process may be superficial, or the entire mucosa may be necrosed. As a rule, the colon is even more involved than the small bowel. In another form the condition is similar to that of a follicular inflammation, the lymphoid elements being swollen and either suppurating

or necrotic, in which case ulcers form; or again, especially in the large bowel, the necrotic pseudomembrane may be more or less continuous, involving especially the cecum or sigmoid and rectum.

**PROGNOSIS.**—The prognosis is usually grave because of the underlying condition.

**TREATMENT.**—There is no treatment for the condition directly. Measures should be directed rather to the provocative diseases.

### CELIAC DISEASE.

**DEFINITION.**—*Chylous diarrhea* or *diarrhea alba* is a serious form of intestinal catarrh, met with especially in young children, in which large, loose stools of pale color occur, extremely fetid, pasty, more or less frothy and somewhat like gruel.

The condition has also been termed *intestinal atrophy with dilatation*, *intestinal infantilism* and *chronic intestinal indigestion*.

**SYMPTOMS.**—There is a gradual onset, without apparent cause; the characteristic stools are associated with wasting, anemia, and progressive loss of strength. The tympany gives rise to an apparent abdominal fullness, more or less boggy. The course is, in general, afebrile and the termination frequently fatal, though under suitable dietetic measures rapid improvement sometimes occurs.

As to the diagnosis, there are to be noted merely the characteristic stools, absence of fever, and serious progressive systemic disturbances occurring in a young child. The etiology is unknown. No constant morbid tissue change is known, though atrophy of the intestinal wall, most marked in the mucosa, is often present.

**TREATMENT.**—Howland called attention to a marked intestinal intolerance to carbohydrate in these cases, and has had good results with a dietetic treatment divided into 3 stages: (1) **Protein milk** alone, until the stools are firm, distention slight, gas not in excess and appetite good. (2) Protein milk plus almost pure **protein foods**, especially curd without whey, scraped meat, certain cheeses, egg white and eventually whole egg. The duration of this stage may be many months. (3) Very gradual addition of carbohydrates, beginning with low carbohydrate (5 per cent.) vegetables and ending with bread, cereals and potato. Haas has warmly recommended addition of **ripe bananas** to the diet as soon as the diarrhea has been controlled by the protein milk. **Saccharin** should be used for all sweetening. The older palliative treatment consisted in the use of **castor oil** followed by **enemas**.

### SPRUE OR PSILOSIS.

**DEFINITION.**—A tropical, or less often subtropical, disease, occurring especially in those not native of the regions where the disease is encountered, and characterized by a chronic inflammation of the mucosa of more or less of the entire alimentary tract, from mouth to anus, with severe general disturbances and a tendency to relapse.

**SYMPTOMS.**—The most prominent manifestation is the occurrence of frequent large, loose stools, frothy, pale in color, and usually with an offensive odor, together with more or less abdominal distention, loss of flesh, anemia, and ulceration of the mucosa of the mouth and throat.

Indeed, the name psilosis was given by Thin, from a Greek word meaning bare, with the idea of expressing the fact that rawness of the mucosa is the chief feature. In some cases there are noted minute, herpetic vesicles with an inflamed areola, rupture of which results in small, very tender erosions or ulcers, and still larger, denuded patches, with more or less mucopurulent material covering them. These lesions occur on the mucosa of the mouth in contact with the teeth. The papillæ of the tongue are swollen, and the lips and tongue cracked. Between the attacks or after recovery, more or less atrophy of the tongue occurs, with some stiffening of the organ. A glazed appearance of the tongue due to permanent destruction of the mucosa, gastric and intestinal disturbances, gaseous distention, an earthy-colored skin,—often due to pigmentation,—and marked irritability and mental disturbances characterize the condition. One remarkable feature is the latency of this affection, even after removal of the patient from the tropics. In some instances the disease makes its appearance or recurs in non-tropical regions many months after apparent recovery.

As sprue progresses, an anemia of typical secondary type develops. A marked leucopenia may ultimately result. There are microcytes and megalocytes, together with poikilocytosis. Polychromatophilia and basophilic degeneration are also not uncommon. In severe cases, especially toward the termination of the disease, the blood-picture may resemble very closely that of progressive pernicious anemia. The blood examination is useful for determining the progress of a case of sprue and its ultimate prognosis. Nothing resembling para-

sites was ever seen in the blood of the author's cases. Low (Jour. Trop. Med. and Hyg., May 1, 1912).

**DIAGNOSIS.**—The condition of the mouth and tongue, the tendency to remissions and relapses, the character of the stools, and the fact that the disease is usually tropical in its distribution are features of assistance in the diagnosis.

**ETIOLOGY.**—Chief among these is residence in the tropics, usually over a long period of time. Exhausting disease or pregnancy, prolonged lactation and lues invite the occurrence of the disease. As to the direct exciting cause nothing is known. Musgrave states that amebæ coli are often present, but it is well known that these organisms are often present in the stools of individuals residing in the tropics. Most common in Java and Cochin China, the disease constitutes some of the chronic diarrheas of the West Indies, Africa, India, Ceylon, the Philippines, and tropical America.

**MORBID ANATOMY.**—Sprue is a progressive catarrhal inflammation of the mouth and alimentary tract, leading to atrophy and secondary fibrous tissue formation, which, *e.g.*, in certain cases of pernicious anemia, are doubtless in a measure responsible for the grave changes in nutrition, progressive loss of weight, and anemia. The tissues are everywhere dry, so that bodies mummify rather than decompose. In the intestine, moreover, are to be found hyperemia, erosions, ulcerations, pigmentations, and cicatrices. Ulcers are especially frequent in the colon. The lymphatic apparatus of the bowel and the mesenteric glands are enlarged, and the former are prone to ulcerate.

Out of 573 typical cases of sprue studied in Porto Rico, the writer found 501, or 87.4 per cent., positive for *Monilia psilosis* by mycologic or serologic examination. The higher the social scale, the more cases of sprue were observed. Typical sprue is most frequently preceded by a physiologic glandular deficiency syndrome with pallor, lassitude, mental hebetude and gastrointestinal derangement. The output of the digestive glands is markedly reduced and the intestinal contents show a high acidity. This is due to an excessive quantity of vitamineless cereals and sweets, and produces a medium favorable for *M. psilosis*. Cure depends more on the complete abstraction of sugar of commerce and vitamineless carbohydrates from the diet than any other therapeutic combination. B. K. Ashford (Amer. Jour. of Trop. Med., Mar., 1922).

There is a large proportion of sprue in the South, and it is not restricted by any degree of latitude. It is probably greatly confused with pellagra and, on account of the element of transmissibility, warrants the most careful study. It is possibly associated with a monilia. The attendant digestive disturbance is greatly improved by the feeding of bile salts. W. H. Lewis (South. Med. Jour., Nov., 1925).

**PROGNOSIS.**—The condition is always a serious one, with a possibility of relapse; yet a goodly proportion of patients recover under treatment.

**TREATMENT.**—To be effectual, this must be applied early. In every instance the food should be as bland and unirritating as possible; milk treatment—especially predigested milk—affords the best results. The character of the bowel movements should be frequently noted as a guide to the continuance of a strict milk diet. The milk should be taken warm, and preferably sipped. An occasional

dose of castor oil, followed by an enema, should be administered. Rest in bed during the active stages of the disease, with concomitant use of a broad abdominal binder, is indicated. Upon improvement in the stools the amount of milk may be gradually increased. The use of strawberries has been regarded as valuable in any stage of the disease. Gradually an egg and well-boiled arrowroot-starch may be added to the diet. T. R. Brown has advocated giving pancreatin and calcium carbonate or lactate, and Bovaird, hydrochloric acid where there is an acidity.

Following treatment described: Complete rest in bed, with a strict milk diet at first. Mouth kept scrupulously clean with a dilute alum and phenol mouthwash, with a cocaine and phenol mouthwash for painful patches on the tongue. Intensive alkaline treatment: Sodium bicarbonate, 1 dram (4 Gm.) by mouth 3 times daily for the first 3 days, then 2 drams daily for 8 or 10 days, and then 3 drams for several weeks; dose to be decreased if there is drowsiness. In severe diarrhea, phenyl salicylate, 5 to 10 grains (0.3 to 0.6 Gm.), may be added; also, if urine becomes too alkaline. In the rare cases with constipation, magnesium carbonate, 10 to 20 grains (0.6 to 1.3 Gm.), is substituted for the phenyl salicylate. In 6 cases, intravenous injections of bicarbonate were added, 10 to 20 ounces (300 to 600 c.c.) of a 2 or 4 per cent. solution being given slowly every day or alternate day for 12 injections, to be repeated after an interval of 1 or 2 weeks. Addition of this alkaline treatment to the usual diet increased the rate of improvement. Castellani (Brit. Med. Jour., Mar. 5, 1921).

The patient is put to bed for the 1st 14 days and given only milk, beginning with 3½ to 4 pints a day, taken warm with a teaspoon at regular intervals, and increasing by ½ pint a day, till at the end of a fortnight 7 to

7½ pints are taken daily. **Calcium lactate** is given in cachets containing 15 grains (1 Gm.) each, thrice daily, and thyroid-free **parathyroid extract**, ⅓ grain (0.0065 Gm.) twice daily. For constipation, a small dose of **liquid paraffin** is probably best. From the 10th day on, some plain biscuits may be allowed, and later a gradual increase of diet. The patient may be permitted to be up for an increasing time each day. After 3 weeks he can take usually milk puddings, eggs, fish, potato, carrot, bananas, and in the 4th week, chicken and non-acid fruits. The calcium can be reduced in the 3d to 4th week and probably stopped at the end of the 4th. The parathyroid is continued till the 5th week, next reduced to ½ doses for a week, and then further reduced and stopped after 6 to 7 weeks. It should be continued until the ionic calcium has reached normal (10.4 to 11.4 mgm. per 100 c.c., while in severe sprue the calcium falls to 6.5 mgm.). H. H. Scott (Lancet, Mar. 21, 1925).

### HILL DIARRHEA.

**DEFINITION.**—A diarrheal disorder met with in elevated places, in tropical and subtropical countries, and occurring especially in persons recently removed from lower levels. Frequent frothy, liquid, or pasty stools, with anorexia and lassitude, and a tendency to relapse, are the chief features. The condition is of special importance in the tropics, as it often invites more serious conditions, such as sprue or dysentery.

**SYMPTOMS.**—Flatulent dyspepsia; loss of appetite; malaise; light-colored, more or less frequent stools, followed by a white flux or so-called "diarrhea alba," with or without pain, and a gradual development of loss of flesh and anemia are the important features. The prognosis is good. History and environment are the important diagnostic features.

**ETIOLOGY.**—Apart from the fact that removal to higher levels invites the disease in the tropics, no definite cause is known to exist.

**PATHOLOGY.**—It is probable that a variety of tropical disorders characterized by diarrhea occur, all bearing some mutual relationship. The lesion in hill diarrhea is believed to be catarrhal and not atrophic, as is the case in sprue.

**TREATMENT.**—Rest and a bland, absolute milk diet are necessary. In some instances the milk should preferably be predigested. If the disease continues, removal from the locality is imperative.

### CHOLERA MORBUS.

**SYNONYMS.**—Cholera nostras, sporadic cholera.

**DEFINITION.**—A diarrheal disease occurring in the summer months, characterized by repeated vomiting, purging colicky pains, rapid and profound weakness, and muscular cramps.

**SYMPTOMS.**—The condition is often rather abrupt in onset. It occurs only in the heat of summer and especially in the temperate zones, and is initiated with vomiting, diarrhea, and colicky abdominal pain. After the stomach is emptied of the food, bile and mucus continue to be evacuated for some time, after which there is non-productive retching. The stools, at first fecal, soon become watery and even resemble the rice-water stools of true cholera. The temperature varies within wide limits; even hyperpyrexia may occur. Thermometric readings should always be rectal. The features become pinched, the skin cool, and the pulse small and rapid; muscular cramps set in, espe-

cially in the legs; thirst is intense, and water often serves to excite further effort at vomiting. The urine diminishes in amount and becomes high colored and albuminous.

**DIAGNOSIS.**—The absence of an outbreak of true cholera alone serves to differentiate a well-marked case of cholera morbus from the Asiatic form. The history is important in order that one may exclude irritant poisons, arsenic, or ptomaine poisoning. A bacteriological examination is usually unnecessary in an individual case, but may be imperative if for any reason a suspicion of true cholera arises.

**ETIOLOGY.**—Among the predisposing factors, season is the most important, as in cholera infantum. It is probable that some of the various forms of the dysentery bacillus may be responsible, though spirilla have also been accused, notably that of Finkler and Prior. Excessive amounts of food, tainted food, and the use of unripe fruits may all play their part during the warm months.

Out of 114 persons in an institution, 37 showed more or less serious symptoms after a meal of haddock killed four and a half days previously. The fish was apparently fresh and firm and had been boiled as usual for eight minutes after having been cut in small pieces. Fish should not be held back by dealers or housekeepers until Friday, but should be delivered as soon as possible after the fish are dead, and be cooked at once. Roepke (*Archiv f. Verdauungs-Krank.*, Bd. xiii, Nu. 4, 1907).

**PATHOLOGY.**—As is well known, in the so-called "eliminative diarrheas" occurring in septic conditions there may be no gross change present. In other cases merely hyperemia

and more or less catarrhal swelling of the mucosa are found.

**PROGNOSIS.**—This is usually good, except in young children, old people, or those already debilitated through disease.

**TREATMENT.**—Absolute rest in bed is necessary. All food should be withheld for forty-eight hours, only pure water being allowed. Cataplasms or turpentine stupes to the abdomen, and often the use of a firm binder, afford some comfort. Carbonated waters or frequent sips of Célestin Vichy given ice-cold serve best to allay the thirst. For the relief of the more urgent symptoms one must have recourse to hypodermic injection of morphine, from  $\frac{1}{8}$  to  $\frac{1}{2}$  grain (0.008 to 0.03 Gm.), according to the severity of the condition. This should not, of course, be used in the case of children.

In the beginning a dose of castor oil should be administered, and cereals, broths, predigested milk, or egg and milk should constitute the only dietary for several days.

In an urgent case of cholera nostras in a woman 39 years old the author prescribed as follows: Veratrine, 5 mg. ( $\frac{1}{2}$  grain), to be dissolved in 25 c.c. ( $4\frac{1}{2}$  drams) of diluted alcohol, and then diluted with 200 c.c. ( $6\frac{1}{2}$  ounces) of distilled water. Dose: One tablespoonful the first four times at half-hour intervals; after that every two hours. At the end of one hour the diarrhea and vomiting were arrested. Next morning the temperature was normal and the pulse good. Satisfactory results were also obtained in a number of other cases. G. Maetzke (*Zeit. f. aertz. Fortbildung*, S. 713, 1909).

## CHOLERA ASIATICA.

**DEFINITION.**—A specific, infectious or communicable disease, due

to the comma bacillus of Koch, and characterized by violent purging, repeated vomiting, cramps, suppression of urine, and collapse, a more or less marked febrile reaction, and a high mortality.

**HISTORICAL NOTE.**—Hippocrates and later Galen refer to cholera, but their allusions indicate nothing more than a serious form of diarrhea. The disease has probably been endemic in India for centuries, but the first definite record dates from the early part of the nineteenth century. It is constantly endemic in India, varying in extent and severity, but, curiously, is not known to have spread beyond the confines of Asia till the nineteenth century. It is most ripe in the region of the Delta of the Ganges. It spreads along lines of commerce and travel, and outbreaks elsewhere have been preceded by unusually severe outbreaks in India. Its propagation has been effected by land rather than sea routes, and many epidemics have spread by way of Russia. It first invaded Europe in 1826, the epidemic covering a period of thirteen years. During this time it made its first appearance in Great Britain and America, being carried from Great Britain to Quebec in immigrant ships in 1832. It spread along the Great Lakes as far as the Mississippi and into the United States by way of New York. In the following year it appeared in France, Spain, and Portugal, and in 1834 in Italy and northern Africa. The next outbreak occurred in Europe in 1840, and lasted eleven years, though recurrences occurred in the United States in 1835 and 1836. In 1848 it entered New Orleans from Havre, and spread up the Mississippi and west to California, recurring in 1849. During a third European invasion lasting nine years from 1848,—hence overlapping the previous outbreak,—it was again introduced into the United States by immigrant ships entering New York. In 1866 and 1867 the disease once more visited the United States, though its manifestations were less serious. This was the terminal portion of the fourth European epidemic which lasted from 1863 to 1867. The fifth existed from 1867 to 1873, and again at the end, in 1873, a mild

outbreak occurred in the United States, coming via New Orleans from Jamaica. During the sixth European invasion, 1879 to 1887, Koch, in Egypt in 1883, discovered the specific cause of the disease. The last extensive epidemic to ravage Europe lasted from 1891 to 1895, and, while occasional cases have been brought by ships both to Great Britain and America, no spread of the disease has occurred in either country since 1873, though in 1893 a number of cases occurred in seaport towns of Great Britain. In all of these wanderings of the disease the original source could be traced to India in each instance.

**SYMPTOMS.**—Owing to variations in virulence of the infecting organism and to varying degrees of susceptibility of the host, the clinical picture is more or less inconstant. The period of incubation is not definitely known. Probably never more than ten days, and usually from three to five days, elapse between the receipt of the infecting organism and the appearance of symptoms. Fairly definite stages mark the course of the disease, viz., a premonitory diarrhea, passing into an evacuating phase, then a period of collapse followed by a reactive condition.

In many instances the attack sets in abruptly, with very severe symptoms,—almost constant vomiting, purging, and muscular cramps,—but in others a distinct prodromal diarrheal stage manifests itself, either abruptly or preceded by abdominal, colicky pain, nausea, and vomiting, diarrhea and a sense of depression thereupon supervening. The period of evacuation may be the initial evidence of the disease, as already stated, but whether preceded by colic and diarrhea or not, the frequency of the diarrhea and the profuse liquid stools rapidly exhaust the patient. Tor-

mina and tenesmus are the rule. Within twelve to twenty-four hours, often less, vomiting sets in, and soon both diarrhea and vomiting become constant. There is rapid loss of flesh, cramps of great intensity and localized, even in the abdomen and back, as well as in the muscles of the legs. The features become drawn and pinched, the skin more or less cyanotic or ashen in color, and the eyes deep-set. Thirst is extreme, the tongue is white, and the body surface cold, often moist and clammy. The pulse becomes weaker, more rapid, and finally imperceptible, and the heart sounds are very feeble. The temperature is often low in the mouth and axilla, but the rectal temperature may be 102° to 105° F. At first restless, the patient is rapidly enfeebled and becomes apathetic, though consciousness remains unimpaired. The stools of these cases are at first fecal, rapidly becoming thin and watery and grayish white, containing little bodies resembling rice grains; hence the term "rice-water stools" and "vomit," since these bodies are found also in the vomited material. There are mucin clumps entangling bacteria (agglutinations), epithelial cells, granular material, and occasionally a little blood. Owing to the profuse diarrhea and consequent loss of blood-serum, the specific gravity of the blood is higher than normal.

The stage of collapse sets in very early in those cases with incessant diarrhea and vomiting. Then dyspnea occurs, the skin becomes dry and wrinkled, the voice husky, the urine diminished or suppressed, and coma may supervene and terminate the scene. It is in this stage that the greatest mortality occurs.

After a few hours, up to twenty-four, or even a little longer in less urgent cases, the stage of reaction sets in: diarrhea lessens, the stomach becomes more tolerant, the circulation becomes stronger, the skin warmer, the color improves, urine is again excreted, and strength returns.

About 3 per cent. of 326 patients went into a condition resembling typhoid with tympanites and temperature above 101° F. (38.3° C.) for more than a week. Some of these gave the Widal reaction in the stronger dilutions, but they all recovered within a fortnight. H. Stevens (Brit. Med. Jour., March 25, 1911).

In the uremia of cholera the writer found that the retention of nitrogen in the 34 cases tabulated amounted to from 3.31 to 5.9 Gm. urea per liter of the blood serum in 50 per cent. of the patients. In 10 others it ranged from 1.75 to 2.72 and in only 7 was below this. In another group of 4 cases Ambard's constant was calculated from the urine and blood. The retention of nitrogen in 50 per cent. was thus higher than the figures obtained even with contracted kidney. There must have been formation of urea from the albumin of the body. All these high nitrogen patients died. Valk and de Langen (Nederl. Tijdsch. v. Geneesk., Apr. 14, 1917).

During an epidemic a variety of types is presented. Cholera organisms have been recovered from the stools of apparently normal, symptom-free individuals, while others may be ambulatory, but complain of malaise and loose bowels, with loss of appetite. When the phenomena are a little more severe, with but slight evidence of collapse and a prompt reaction, they are spoken of as *choleraic diarrhea* or *cholerine*. In the most intense types death may occur within a few hours, without vomiting or purging,—the so-called



*cholera sicca*. These cases, however, are rare. Death may occur, too, from embolism or thrombosis causing sudden respiratory, or either prompt or more gradual circulatory, failure. Early coma may terminate in death before the development of the usual train of symptoms; or, after reaction has set in, a relapse may occur with the rapid development of serious or fatal effects. Hyperpyretic cases (rectal temperature) are uncommon and often fatal. A prolonged stage of reaction may occur during which a typhoid state predominates, with dry mouth, lips, and tongue, sordes, delirium, subsultus, bedsores, and, when the issue is not fatal, prolonged convalescence.

In Madras Presidency, as well as in other portions of India, cholera, for a period of twenty-five years, has gone through a regular 6-yearly-cycle, an enormous rise in incidence occurring every seventy-two months. No such periodic trend has hitherto been reported. A. J. H. Russell (*Lancet*, June 13, 1925).

Eruptions may occur, usually urticarial or erythematous, and rarely bullous. When urinary suppression is pronounced, the case is apt to assume a *uremic type*.

Of 102 cases of cholera treated with **hypertonic saline injections** in 1909, only 14 per cent. died in the collapse stage. Fatal collapse can still occur in very severe cases some hours after as much as 4 pints (2000 c.c.) of fluid have been injected into the veins. Nine per cent. of the total cases died in the "stage of reaction," the main feature of which is usually a marked rise of temperature, which either continues high, a typhoid-like state ensuing, or in very severe cases shows a subsequent considerable lowering, with early fatal result. The **cold bath** appears to be the only measure likely to control the temperature, but heart-

failure may ensue, and this of itself is an occasional cause of death in feeble subjects during reaction without any marked rise in temperature. An increase in the respiratory rate is commonly a sign of a severe reaction and an indication for **ammonium carbonate** and **sal volatile**, while if cyanosis ensues **oxygen inhalations** appear to be indicated. **Alcohol should be avoided**, as it tends to increase vasomotor paralysis.

During 1909 lung complications were unusually frequent in Calcutta, 5 per cent. of the deaths being due to them. **Ammoniacal preparations** were here also of most use. The mortality in the uremic stage was 6.9 per cent.

Suppression of urine after cholera is really due to failure of restoration of the circulation through the kidneys, which have become intensely congested and full of hemorrhages during the collapse stage. The obvious indication is to endeavor to force the blood-pressure up to well over 100 mm., steps being taken as soon as reaction occurs, two or three days being then available, as a rule, before very urgent symptoms will ensue. Every patient whose blood-pressure remained for several days below 100 mm. died with uremic symptoms.

The measures used to raise the blood-pressure when deficient in the later stages were the following: (1) Half to 1 pint of **normal saline solution** per rectum every two to four hours, 5 minims (0.3 c.c.) of a 1:1000 solution of **adrenalin chloride** being added to each; (2) **dry cupping over the kidneys** morning and evening; (3) **digitalin** subcutaneously twice a day, and if this fails **strophanthin**, up to  $\frac{1}{400}$  grain (0.00065 Gm.), administered intravenously (apparently successful in 2 cases).

Opium or morphine after collapse has once set in predisposes to uremia later. Leonard Rogers (*Therap. Gaz.*, Nov. 15, 1909).

As to the blood changes, leucocytosis prevails throughout the disease.

but is apt to become rather higher before death, and in the algid types. The increase is especially polymorphonuclear, as would be expected. Owing to the excessive blood-concentration from the loss of water, the result of almost constant vomiting and purging, polycythemia is the rule, with a corresponding increase in hemoglobin.

**Complications and Sequelæ.**—Membranous colitis, tracheobronchitis, laryngitis, or urethritis may occur, as may likewise suppurative parotitis.

Among the less urgent sequelæ are anemia, debility, insomnia, nervousness, marked depression, melancholia, and chronic diarrhea. Abortion is the rule in pregnant women. More serious are pleurisy, pneumonia, and pulmonary edema. Arthritis is not rare. Conjunctivitis is frequent, and occasionally corneal ulceration occurs. Rarely gangrene of the extremities, nose, ears, penis, or scrotum makes its appearance.

Painful muscular cramps may persist for some time after recovery, as may also gastrointestinal disturbances.

**DIAGNOSIS.**—Clinically, the most severe forms of cholera nostras closely resemble Asiatic cholera, but doubt would only exist in some seaport in the event of arrival of a vessel from a locality known to be infected. A bacteriological examination alone would serve to distinguish the two conditions. In view of the well-known epidemic character of Asiatic cholera, it is not likely that errors in diagnosis would often arise.

Ptomaine and mushroom poisoning, or arsenic or sublimate poisoning, may resemble cholera sympto-

matically, but it is scarcely conceivable that errors in diagnosis would occur except in localities where cholera prevails or happened to exist at the time. A study of the intestinal flora would then be indicated.

The resemblance of the algid type of malaria to cholera should always be borne in mind, as its early recognition by finding the parasites in the blood is essential to its successful treatment with quinine. Ptomaine poisoning may cause difficulty, but in several cases the author has found the absence of the typical leucocytosis of cholera of great differential value. Leonard Rogers (*The Antiseptic*, Feb.-Mar., 1909).

In bacteriological examination of alvine discharges or the material taken from the rectum by swabs at the New York Quarantine Laboratory, it was found that nearly half of the cases, even where there was no clinical evidence or special reason to suspect cholera, showed curved bacilli of various sizes and shapes, in many instances resembling the cholera vibrios. Where these forms are numerous, the case should be regarded as suspicious until the cultural characters prove it to be otherwise. The presence of a few actively motile organisms in the hanging drop adds considerably to the suspicion. In cholera carriers and mild cases of this disease the cultures may show the vibrios even though the smear shows very few suspicious organisms. It is usually only in the active cases that the smear and hanging drop, made directly from the discharges or rectal swab, will afford such unmistakable evidence as is required to pronounce the case true cholera from the point of view of the bacteriologist. In all other cases it is necessary to isolate pure cultures and prove them cholera vibrios or otherwise by suitable bacteriological tests. Doty (*Amer. Jour. Med. Sci.*, Jan., 1911).

The rule may be adopted to consider as truly choleraic every choleri-

form vibrio in which one or the other of the two following characteristics is recognized: (1) Agglutination, in the proportion of 1:1000 at least, by a cholera serum the activity of which is 1:4000 or more. (2) Positive Pfeiffer reaction (bacteriolytic test in guinea-pigs).

The following general indications permit in the great majority of cases a positive diagnosis within twenty-four to thirty-six hours: (1) When mucous flakes are available for examination, a microscopic investigation of the same, in stained preparations and in the hanging drop. (2) The isolation of the vibrios, employing for the purpose agar media, at a temperature of 37° C. (a) Plant plates of ordinary suitably alkalinized agar and of Dieudonné's medium, using for the latter a riziform particle, or an equivalent quantity of feces. (b) Plant in 50 c.c. of peptone solution 1 c.c. of fecal matter. After a stay of 6 or more hours in the incubator at 37° C. take several loopfuls from the surface and plant with them several plates of Dieudonné medium and ordinary agar. (c) Investigate the agglutination reaction, using drops for the purpose from the isolated colonies, the properties belonging to cholera vibrios, and secure pure cultures. (3) Demonstrate the character of the vibrios obtained in pure culture by the reaction of agglutination or that of Pfeiffer.

The medium of Dieudonné is prepared as follows: Equal parts of a normal solution of potassa and defibrinated ox blood are mixed and sterilized in the autoclave (sol. A); there is also prepared according to the ordinary technique a nutrient agar, exactly neutral to litmus (sol. B). Seven parts of B are mixed with 3 parts of A and poured upon plates. H. D. Geddings (Public Health and Marine-Hosp. Service of U. S., Report No. 75, 1912).

On sugar-free nutrient agar to which the writers added 1 per cent. saccharose, 0.25 per cent. nutrose and 0.0625 per cent. bluish eosin, the cholera colonies have red centers,

while the colonies of *B. coli* are uniformly pink. Teague and Travis (Jour. of Infect. Dis., June, 1916).

Polyserum method of detecting the cholera germ for rapid diagnosis recommended. In 22 practical trials of the procedure it proved reliable and yielded the germ in pure culture in 8 hours. It is based on the finding of Castellani that mixed agglutinating serums added to culture media prevent development of the corresponding germs only. Thus, if loops of typhoid, paratyphoid and cholera germs are added to a medium containing only typhoid and paratyphoid serums, only the cholera germs will proliferate. I. Iacono (Rif. med., Feb. 5, 1923).

Ordinary agar of pH 7.6 to which has been added 0.5 per cent. of sodium taurocholate constitutes a useful and simple medium upon which to cultivate the cholera germ by direct plating, either from the stool or from a peptone water culture. Maitra and Basu (Calcutta Med. Jour., Nov., 1924).

Comma bacilli were found microscopically in 84 per cent. of the stool films of 495 cholera cases diagnosed bacteriologically. Cytologic elements in the cholera stool are constant and characteristic, and can be employed as a reliable index in 98 per cent. of cases. Of 496 cases, 92 per cent. showed definite concentration of blood. Maitra, Ganguli and Basu (Indian Med. Gaz., July, 1925).

**ETIOLOGY.**—The pathogenicity of the organism isolated by Koch in 1883 and claimed by him to be the sole cause of cholera has been abundantly confirmed. The disease is not contagious in the strict interpretation of that term, and it is generally conceded that the organism must be swallowed in order to produce infection. Hence, contaminated food and drink, whether the contamination has occurred through the medium of flies or in any other way, as by washing

utensils or food with infected water, are necessary for the development and spread of cholera. Drinking-water is by far the commonest source of infection, as was the case in the Hamburg epidemic of 1892. Not much is known as to the factors concerned in individual susceptibility, but, in the presence of infected material, gastrointestinal troubles increase the likelihood of infection, and newcomers into an infected area, as is the case with typhoid fever, are more susceptible than natives. Sanitation, personal hygiene, and pure food and drink are the all-important factors in preventing infection, and this presupposes isolation of every suspect (for quarantine is useless) and the destruction of all stools, urine, and vomited material, or articles which have become contaminated.

The comma bacillus, by which name the organism is most generally known, is comma-shaped, or may be even more twisted, having 1 or 2 corkscrew-like curves. Found chiefly in the intestines and recoverable from the stools of infected individuals and in cases of somewhat protracted course, the organism penetrates the mucosa. *Post mortem* it has been found in some of the adjacent lymph-glands, but it has not been recovered from the blood or viscera.

The organism is variable in size, shape, and degree of mobility, and in the involution stage becomes so changed as to lose all semblance to its rapidly growing forms. It grows well upon many media and slowly liquefies gelatin. Animal experiments lack uniformity in their results. Laboratory animals show practically no susceptibility when the germs are

administered by mouth under ordinary conditions; but after neutralization of the gastric contents and control of the peristalsis with opium, a profuse watery diarrhea may result, the stools containing the organism in vast numbers. Animals can be immunized against cholera vibrios, and the immune serum then acquires bacteriolytic properties. This was first discovered by Pfeiffer and has since become known as "Pfeiffer's phenomenon." The organism also agglutinates when to a suspension of it there is added the serum obtained from a cholera patient or an immune animal. Comma bacilli are killed by exposure to a temperature of 50° C. for an hour. They survive for a day or two at most in distilled water, but may live for months in ordinary river waters. As they are rapidly destroyed by drying, it is only upon moist substances or in water that they can retain their vitality for any length of time.

One must take care in all epidemics of cholera not only to disinfect the stools and other excreta of the patient, but to see that all feces of healthy persons are disinfected, for a slight fecal admixture is all that is needed to cause a flourishing growth of the vibrio in any soil or water. M. Pergola (Il Policlinico; Med. Record, Dec. 30, 1911).

The soil in the coolie quarters at Batavia become hotbeds of cholera whenever the disease is epidemic. The normal flora in the soil and other factors soon destroy the cholera germs on the soil, so that none survive longer than 2 days when the ground is damp; during dry weather, up to 4 or 6 days. Flu (Meded. van den Burg. Geneesk., No. 3, 1917).

It is generally conceded that no specific soluble extrabacterial poison is produced by the comma bacillus.

In the rabbit the strongly acid gastric juice destroys the micro-organisms readily. Apparently the route of the vibrio from mouth to intestine is through the general circulation. The point of election is in the vicinity of the ileocecal valve. Sanarelli (*Presse méd.*, Nov. 16, 1916).

Immunity may be produced in the usual way in laboratory animals, *i.e.*, by first employing injections of dead organisms and gradually administering minimal amounts of attenuated living organisms. Finally the animal will survive injections of large amounts of untreated living bacteria. A serum thus produced has the power to protect against many times the lethal dose of the living vibrio.

**PATHOLOGY.**—One of the most striking post-mortem evidences is the rapidity with which rigor mortis sets in. It is not at all unusual for muscular contractions to occur in the limbs and in the facial and ocular muscles, so that with the post-mortem elevation of temperature, which is not unusual, these grotesque phenomena are often rather uncanny. There are no changes of an absolutely definite type, though the marked emaciation with dryness of the skin; the dark, thick blood; the swollen and sometimes hyperemic mucosa, with a low-grade peritonitis, the stickiness probably being due to the abstraction of water; the characteristic bowel contents, the small spleen, and the cloudy swelling of the liver and kidneys, the latter being especially involved and showing advanced epithelial degeneration, are decidedly suggestive changes. The bladder is generally empty. The right side of the heart and the venous system are apt to be found engorged, while the left heart and the arteries

are practically empty. All the tissues are relatively dry, owing to the tremendous loss in their watery content. Bacteriological study reveals, of course, the true nature of the disease.

The cholera vibrio is present in large numbers in the bile, often in pure culture. In some cases the bacillus is retained in the bile much longer than in the intestine after apparent recovery. In about 10 per cent. of cases there is an acute cholecystitis due to the presence of the cholera bacillus in the gall-bladder. Usually the process is an acute hemorrhagic, rather than suppurative, condition. In the remaining cases there is only a catarrhal cholecystitis, with thickening of the bile and an increase of mucus. The bile makes an excellent emergency medium for cholera cultures. The bone-marrow undergoes an acute hyperplasia in cholera. In addition it shows inflammatory changes. At times a real osteomyelitis may develop in the course of the disease. Kouleshi (*Roussky Vrach*, Oct. 31, 1909).

The stage of reaction and uremia in cholera and the acid intoxication of diabetes have the following features in common: (1) There is a well-marked tolerance for alkalies. (2) The relative and absolute amounts of ammonia in the urine are considerably increased in both diseases. (3) In both diseases a diminished alkalinity of the blood has been reported. (4) Injection of alkalies in the late stages of either disease usually modifies the course without affecting the ultimate termination. Acetone and diacetic acid have been noted in the urine of cholera cases, but no excess of acid has been found which corresponds to the quantities of *b*-oxybutyric occurring in diabetes.

Loss of alkali from the body apparently may result from a pronounced diarrhea, this loss giving rise to a relative acidosis. It also is conceivable that there may be an excessive quantity of acid present, resulting

in the production of an absolute acid intoxication in cholera. Sellards and Shaklee (*Philippine Jour. of Sci.*, Feb., 1911).

Although the urine contains no nitrous acid in healthy persons, that of fresh cholera cases contains large quantities, more than sufficient to poison. When nitrous acid appears in the stomach and intestines it excites cholera-like symptoms. Emmerich (*Münch. med. Woch.*, May 2, 1911).

The resemblance in certain points between cholera and Addison's disease is so marked that it suggests that cholera may be merely an acute specific enteritis with toxic nervous symptoms, especially of the innervation of the cardiovascular apparatus, due to deficient adrenal functioning. The results obtained with **epinephrin** in 9 cases justified further trials of it in the treatment of cholera, even in large doses. Piovesana (*Gaz. degli Osped.*, May 26, 1912).

The cholera organism is occasionally recoverable from the bile where absent from the feces, and routine examination of both bile and feces is important. Crowell and Johnston (*Philippine Jour. of Sci.*, Mar., 1917).

The possibility of a fundamental element in the pathogenesis of cholera which is lacking in other infectious diseases is suggested by the sudden and often violent onset with early collapse, fall in blood-pressure, hypothermia and loss of fluid through the intestine. These symptoms more resemble high intestinal obstruction than any other enteric infection. Precipitating filtered watery cholera stools and intestinal fluid with alcohol yielded a poisonous substance producing, when injected intravenously or intraperitoneally in dogs, symptoms and lesions identical with those following experimental closure of duodenal loops. Goodpasture (*Philipp. Jour. of Sci.*, Apr., 1923).

Anuria in cholera is due to pressure by the swollen epithelial cells on the tubules which lead to the glomeruli, thus preventing function of the latter.

S. Fujii (*Jour. of Orient. Med.*, Aug., 1924).

**PROGNOSIS.**—This necessarily varies with the extent of the outbreak and the type of epidemic, some epidemics being more severe than others. The mortality is usually large, and in the severer outbreaks 50 per cent. and even more of those manifesting symptoms succumb. The disease is especially dangerous in the extremes of life, though nursing children are very rarely infected. Women are infected less frequently than men, but the disease is more apt to prove fatal in pregnant women. Chronic renal disease, cardiovascular disease, malaise, and depraved nutrition all exert an unfavorable influence on the prognosis.

**PROPHYLAXIS.**—The most important factor is the isolation of infected individuals and the complete destruction of all vomitus, dejecta, urine, and infected clothing. All milk and water used should previously have been boiled, and all food and drink should be carefully guarded against possible infection by flies and dust, as well as from contamination of utensils through the use of polluted water for washing purposes. In the presence of an epidemic, digestive disturbances should be cautiously guarded against, as they increase susceptibility. Through protective inoculation, first practised by Haffkine in India, and later by Strong in the Philippines by a process devised by himself, fairly good results have been obtained, but these results do not lessen the desirability of efficient sanitation, personal hygiene, and the absolute isolation of infected individuals, with destruction of all infected material.

In the **prophylaxis** of cholera all **water** used for drinking or cooking purposes should be **boiled**; likewise all milk. The germ is readily killed by acids and infection may be prevented by the use of dilute mineral acids internally, *e.g.*, dilute **sulphuric acid**, a few drops thrice daily. Even carbonic acid gas in **aërated waters** (not soda water) will kill the germ, provided there have elapsed at least three hours between the bottling of the gas and its use. Five to 10 drops of dilute sulphuric acid to a bottle of lemonade is most useful. Floors of houses may be **washed with potassium permanganate**,  $\frac{1}{2}$  ounce (15 Gm.) to a pail of water. Wells should be **disinfected** to the extent of 1 ounce (30 Gm.) of **permanganate** to every 3 feet of water. If after half an hour there is a red color in the water in the well, enough permanganate has been put in; if not, more should be added. There should remain a slight red color in the water at the end of twenty-four hours. It is best to add the permanganate at night, so that by next morning the water will be usable and its color not so objectionable. A. G. Newell (Indian Public Health, Sept., 1908).

A patient with cholera or suspected of having cholera should be **isolated** immediately. The room or ward should be rendered fly-proof by **screening**. In the room there should be a large vessel containing 5 per cent. solution of **carbolic acid** crystals for the immediate reception of soiled linen. The **stools** and **vomit** should be **disinfected** at once by adding an equal volume of 5 per cent. **carbolic acid** solution, 5 per cent. **formaldehyde** solution, or **milk of lime**. The mixture should be covered and allowed to stand for two hours before ultimate disposal. There should also be a washstand and basin just inside the door of the room and every person before leaving the room should be required to thoroughly wash and **disinfect the hands** with a 1 per cent solution of **lysol** or other good disinfectant. Gowns should be put on

upon entering the sick-room and taken off just before disinfecting the hands and leaving the room. These gowns when soiled should be placed with other soiled linen in the tub of **carbolic acid** solution.

There should be a thorough surface **disinfection** of every room in the house in which a case of cholera or suspected cholera is found. This is secured by cleansing of the walls and floor with disinfecting solution ( $2\frac{1}{2}$  per cent. **carbolic acid** or 1:1000 **bichloride** solution).

Convalescents should have three vibri-negative reports of stools on successive days before being discharged. A. J. McLaughlin (U. S. Public Health and Marine-Hosp. Service, Report No. 53, 1910).

During times of cholera epidemic, bacillus carriers are numerous, and the writer found from 6 to 7 per cent. of carriers among healthy individuals living in the infected neighborhoods in Manila. A. J. McLaughlin (N. Y. Med. Jour., Jan. 21, 1911).

For detecting cholera carriers, the author adds saccharose and sodium carbonate to the Dunham peptone solution until the medium is alkaline, phenolphthalein being used as indicator. If a moderate number of cholera vibrios are introduced, together with other organisms, the culture becomes decolorized after five to eight hours' incubation. Bendick (Jour. Amer. Public Health Assoc., Dec., 1911).

The author holds that **abstinence from nitrate-containing food** is the main point in **prophylaxis**, and, on suspicion of incipient cholera, advises sipping a 1 per thousand solution of **amidosulphonic acid**, which almost instantaneously transforms nitrous acid into free nitrogen. Emmerich (Münch. med. Woch., Nov. 26, 1912).

Of patients about to leave a cholera hospital, 36 per cent. were excreting the cholera organism in their stools. Of 27 close contacts 6 were likewise excreting it, though apparently quite healthy. The germ was found on the external appendages of flies and also in

their alimentary tracts. The main channels of cholera transmission are healthy "carriers" and flies. E. D. W. Greig (Indian Med. Gaz., Jan., 1913).

In **Haffkine's vaccine**, living cholera germs are administered. Kolle showed, however, that heat-killed cultures will give equivalent results. **Kolle's vaccine** is made by cultivating a virulent strain on flasks of agar for 24 hours, making a suspension with salt solution (1 loopful in 1 c.c.), shaking, heating to 53-60° C. for ½ to 1 hour, culturing for sterility, and preserving with 0.5 per cent. phenol. For cholera prophylaxis, 2 subcutaneous injections are given, 1 week apart, the first dose being 1 c.c. and the second, 2 c.c. Heat-killed vaccines were used with favorable results during the World War. The results are epitomized in Savas's report that among Greek troops the cholera incidence was 7 per 1000 in those receiving 2 vaccine injections as against 93 per 1000 in the unvaccinated. Thorough vaccination soon dispelled the disease in cholera-infected communities.

The writer calls attention to the efficiency of **anticholera vaccination** in the Balkan wars. Whereas the incidence of cholera among 14,332 unvaccinated officers and enlisted men was 5.75 per cent., that among 21,216 men vaccinated once was but 3.12, and among 72,652 men vaccinated twice, 0.43, according to Arnaud. In the civil population of Greece, Cardamatis reported percentages of 2.12, 0.26, and 0.01, respectively. The vaccine used consisted of cultures on agar heated to 60° C. for 1 hour. Three injections at 5-day intervals are essential if immunity is to be acquired, with doses of 1, 1.5, and 2 c.c. C. Dopter (Paris médical, Jan. 2, 1915).

Nine writers have recorded favorable experiences with Besredka's method of **vaccination by mouth**

against typhoid fever, dysentery and cholera. Combined administration of a bile pill and living or killed cholera germs *per orem* in rabbits yielded an immunity such that an otherwise fatal amount of cholera germs could be injected intravenously without harm. Seven human subjects were then given a bile pill and a tablet of desiccated cholera germs on an empty stomach on 3 successive days, whereupon their blood showed a marked increase of anticholera agglutinins and bacteriolysins. P. Peverelli (Ned. Tijds. v. Gen., Aug. 2, 1924).

The antibodies produced by injection of cholera vaccine persist in the blood between 6 and 10 months. The wholesale vaccination in areas where outbreaks occur every year, as well as in places where sporadic cases occur during the off season, should be completed at least 1 month before the time when an epidemic may reasonably be expected. O. Schöbl and J. Andaya (Philipp. Jour. of Sci., Mar., 1925).

**TREATMENT.**—**Rest in bed**, warmth, with carbonated beverages, whey, egg-albumin, and peptonized milk which has been previously boiled should constitute the sole régime. A preliminary dose of **castor oil**, and hot applications to the **abdomen**,—either **spiced plasters** or an occasional **turpentine stupe**,—may be of some value. During the active stage of the disease, opium in some form is imperatively demanded. The hypodermic use of **morphine** is to be given preference. As little should be given by the mouth as possible. Frequent **washing out of the bowel**, either with a 1 or 2 per cent. **quinine bihydrochloride solution** or one consisting of **creolin** in 2 quarts of water, together with the use of normal **saline solution intravenously**, in an attempt to make up for the fluid lost, is especially indicated. During the stage of reaction it is necessary carefully to



regulate the diet; and in those cases in which colic and muscular cramps occur, to meet them by relaxing **warm baths** and, if required, the use of **opium**.

The indication to keep up the circulation and so re-establish the functions of the kidneys in cholera is met partly by the use of drugs. The following combination may be employed in doses of 20 minims (1.25 c.c.), in an ounce (30 c.c.) of water, every two, three, or four hours, according to the state of the pulse:—

℞ *Caffeina sodio-salicylatis* ... gr. iiss (0.16 Gm.).  
*Sparteina sulphatis* ..... gr. ss (0.03 Gm.).  
*Liquoris atropina* (B. P.) ..... ℥j (0.06 c.c.).  
*Spiritus vini gallici*, q. s. ad ..... ℥xxx (1.25 c.c.).

Coldness of the extremities and profuse clammy perspiration are readily controlled by the **atropine**; in addition, **hot-water bottles** or **foot and body warmers**, **sinapisms** to the **calves**, and **friction of the limbs with dry ginger powder** are often resorted to. To encourage urinary secretion, **poultices of digitalis leaves** and **dry cupping** may be utilized.

The only nourishment allowable in cholera is **hot black coffee**, without milk or sugar. This may be given whenever the patient requires a drink, is usually retained, and quenches thirst better than cold fluids. Choksy (Lancet, April 30, 1907).

Following treatment of cholera found effectual in a large experience in Siam: The patient first receives from 4 to 6 tablets (at once) of the following composition:—

℞ *Cocaine hydrochloride* . gr.  $\frac{1}{20}$  (0.003 Gm.).  
*Cresote* .... ℥ $\frac{1}{8}$  (0.007 c.c.).  
*Cerium oxalate* ..... gr. ij (0.13 Gm.).  
*Pepsin* ..... gr.  $\frac{1}{4}$  (0.016 Gm.).  
*Tincture of nux vomica*. ℥ $\frac{3}{8}$  (0.02 c.c.).

This absolutely controls the vomiting in most cases. The patient is instructed to chew the tablets up thoroughly before swallowing.

From three to five minutes after the cocaine compound, 1 or 2 tablets of the following formula are chewed and swallowed:—

℞ *Morphine sulphate* ..... gr.  $\frac{1}{6}$  (0.01 Gm.).  
*Extract of hyoscyamus* ..... gr.  $\frac{1}{8}$  (0.008 Gm.).  
*Nitroglycerin* . gr.  $\frac{1}{100}$  (0.00065 Gm.).  
*Citrated caffeine* ..... gr. ss (0.03 Gm.).  
*Capsicum*,  
*Camphor*, of each ..... gr.  $\frac{1}{4}$  (0.016 Gm.).  
*Tincture of digitalis* ..... gtt. v (0.16 Gm.).

Every few minutes, until the pulse can be felt at the wrist, a tablet of **nitroglycerin**,  $\frac{1}{100}$  grain (0.00065 Gm.) with 2 minims (0.12 c.c.) of the tincture of **digitalis**, is given.

As soon as the pulse is felt at the wrist, no matter how feebly, the prognosis becomes more favorable.

In the mean time the patient is given the following mixture:—

℞ *Tincture of eucalyptus* ..... f℥iv (120 c.c.).  
*Spirit of camphor*. f℥ij (8 c.c.).  
*Tincture of capsicum* ..... ℥xxx (1.8 c.c.).

This is taken at one dose diluted with an equal quantity of water, and from teaspoonful to tablespoonful doses of tincture of **eucalyptus** are given concurrently every hour until reaction sets in. **Mustard plasters** and the application of **heat to the body** are not neglected.

To keep the blood-serum in the vessels and thus prevent shock and dehydration, the author uses heroic doses of **tannic acid**. He has given 120 grains (7.8 Gm.) of pure tannic acid in twenty-four hours with the happiest results, administering 10-grain (0.65 Gm.) doses after every bowel movement, or, oftener, 20 grains (1.3 Gm.) every hour irrespective of bowel movement.

A great many patients promptly react as a result of this treatment, and then are attacked by suppression of urine, which often occurs at this time. To combat this he employs tincture of **eucalyptus** in addition to the **digitalis** and **citrated caffeine**, which also act as diuretics. The most vital thing in the treatment at this point is the **absolute prohibition of food** for thirty-six hours or longer. A relapse can occur from the eating of a slice of orange or a teaspoonful of soft-boiled rice. Braddock (Jour. Amer. Med. Assoc., June 15, 1907).

The writers emphasize the importance of uremia as a sequela which the textbooks speak of as the "reaction stage" or state of "cholera typhoid." The symptoms of this stage consist of a bounding pulse, labored breathing, flushed face, and coma. The severe cases of collapse may be expected to develop some uremia. The patient should be encouraged to **drink large amounts of water and of lemonade**. **Hot packs** may be used.

Of all measures used to induce the kidneys to secrete, large **rectal injections of hot saline solution** were most successful. Often enemata of 4 to 6 liters were given five or six times in the twenty-four hours. H. J. Nichols and V. L. Andrews (Philippine Jour. of Sci., April, 1909).

Value of a large injection of **morphine** in cholera as soon as the disease is suspected emphasized. If persons sleep after an injection of  $\frac{1}{2}$  or  $\frac{1}{4}$  grain (0.03 or 0.02 Gm.) of morphine, their chances of recovery are good; morphine does not induce sleep in those patients who are badly collapsed, but only stops the diarrhea and vomiting. R. W. Burkitt (Jour. of Trop. Med. and Hyg., July 15, 1909).

**Water or normal saline** may always be **freely given by the mouth** in cholera, and although it is frequently vomited some toxin is probably evacuated with it. Of much greater importance are **saline enemata**. When there is a fair pulse, 1 pint by rectum

every 2 hours will often tide the patient over. Leonard Rogers (Ther. Gaz., Nov., 1909).

In the earlier milder cases the author has found **salol** and **benzonaphthol** very useful. Many, however, would probably have died in spite of salol, **chlorodyne**, etc., had he not resorted to **creolin**—4 to 6 drops, rolled about in flour with a stick, then turned on cigarette paper, gently enveloped in it, and swallowed. Four to 6 doses of this bolus were given, repeated every second or third hour. The drug must be used fresh.

Preparations of **ether**, **valerianate of ammonium**, **friction**, **counterirritation**, **packing in hot towels**, etc., are useful to bring about reaction, but the temperature must be carefully watched. Anything above 102° F. (38.9° C.) is already grave in cholera, and not much should be done to bring about overreaction. Basil (Brit. Med. Jour., Sept. 24, 1910).

**Sodium iodate** given subcutaneously in 82 cases of cholera. One c.c. (16 minims) of a 7 per cent. solution was injected every three hours; in the case of children a 3 per cent. solution was employed. The mortality was 25.6 per cent., while in 343 cases treated otherwise it was 46 per cent. The injections are painless and cause no reaction. V. Oufioujaninov (Prescriber, May, 1911).

**Uremia** in cholera can be prevented by administering rectal **saline** after the intravenous. **Persistent vomiting** is checked by dilute **hydrocyanic acid** and minute doses of **wine of ipecac**. **Hiccough** in one case persisted for six or seven days and finally ceased after a solution of **camphor** in alcohol (30 grains—2 Gm.—to the ounce—30 c.c.) on a lump of sugar had been given. **Hyperpyrexia** can be overcome by administering the **rectal saline injection cold**. **Ulceration of cornea** may occur. It is advisable to wash the patient's eyes frequently with **saline** and apply some form of ointment, especially **iodoform ointment** (2 grains—0.12 Gm.—to 1 ounce—30 c.c.). **Calomel** in minute and con-

tinued doses, up to 4 or 5 grains (0.26 or 0.3 Gm.), is useful in restoring the yellow color of the stools. If it fails a **mustard plaster over the liver** will be of assistance. G. B. Sarkar (Calcutta Med. Jour., June, 1911).

In the algid cases of cholera **hot baths** are of occasional use, frequently leading to cessation of diarrhea and vomiting and relieving the cramps. The latter are also helped by **rubbing the skin with brushes moistened with camphor or soap liniment**. Moderate diarrhea may be treated by **salol**, about 8 grains (0.5 Gm.), three or four times a day. In more severe cases, where nausea is marked, but there is no vomiting, **ippecac** may be given and vomiting produced by giving much **warm water** and **tickling the fauces**. If these methods do not relieve the diarrhea, pure resublimed **naphthalin**, 2 to 8 grains (0.13 to 0.5 Gm.), or **benzonaphthol** in the same dosage several times a day, may be given. A **Priessnitz compress** continued through the night may be used to quiet peristalsis. In cases of *cholerae*, **salol** was begun as above, and if the symptoms did not respond to treatment **hot baths** were begun. Their duration was fifteen to thirty minutes, at a temperature as hot as could be stood by the patient. G. A. Friedman (Med. Rec., Aug. 19, 1911).

In 1 case the author found it necessary to give 5 **hypertonic saline injections**, the total quantity of solution injected being 20 pints. The injection is made into a vein laid bare at the bend of the elbow, or, if there is difficulty in finding a suitable vein here, the large vein which usually crosses the internal malleolus may be chosen. A small silver cannula with a stop-cock is tied into the vein. L. Rogers (Brit. Med. Jour., Sept. 16, 1911).

**Potassium permanganate** given internally with some success in cholera. Dose, 0.4 to 0.5 Gm. (6 to 7½ grains) *per diem*, dissolved in 400 to 500 Gm. (½ to 1 pint) of pure water and given every half-hour. Drug continued two or three days in diminishing doses. Especially valuable in cases with

hemorrhage. **Iodine tincture** given in 42 cases, with 34 recoveries. Dose, 40 to 60 minims (2.4 to 3.6 c.c.) daily, dissolved in 250 Gm. (½ pint) of distilled water, given every hour. Copious **bowel irrigations with warm iodine solution** or 1:1000 **potassium permanganate solution** also used with benefit in severe cases. J. Logotheti (Bull. méd., Dec. 6, 1911).

In cholera the author administers by rectum and intravenously the following **hypertonic saline solution**: **Sodium chloride**, 120 grains (8 Gm.); **potassium chloride**, 6 grains (0.4 Gm.); **calcium chloride**, 4 grains (0.26 Gm.); water, 1 pint (500 c.c.). The object is not only to replace the water and salts lost, but to raise the salts in the blood somewhat above the normal, so that the osmotic currents will tend to cause fluid to run into the blood rather than out, and the diarrhea will be checked instead of increased, as it is by the use of normal saline. Rogers (Proceed. Royal Soc. of Med., Dec., 1911).

**Intraperitoneal saline injections** recommended in cholera. A blood-pressure which falls below 70 continues to fall rapidly, as a rule, to between 30 and 40, and preparations for the injection are made as soon as the pressure is below the first figure. Hypertonic solution is allowed to run in at the rate of about a pint in 4 or 5 minutes, the temperature being regulated in the same way as for the intravenous method. A fair clinical indication of when to stop is when the patient experiences a desire to micturate. T. H. Bishop (Indian Med. Gaz., April, 1912).

Vasoconstrictors must be avoided. A sufficient amount of fluid must be maintained in the circulation to insure a free supply to the kidneys. **Nitrites** constitute the sheet anchor for the latter purpose, after the **intravenous injection of hypertonic saline** to combat collapse. G. B. Sarkar (Practitioner, Nov., 1912).

The remarkable tolerance of cholera patients for **adrenalin** shows that it supplies a much needed active prin-

ciple. The writer injected it subcutaneously in doses of 0.004 or 0.006 Gm. ( $\frac{1}{15}$  or  $\frac{1}{10}$  grain) in the 24 hours, keeping it up for several days, supplemented by **saline infusion**. Others have found it very efficient. Naamé (Presse méd., Dec. 10, 1914).

The prognosis of cholera is very good if proper treatment is begun on the first day. **Hypertonic salt solution** is best for cases in severe collapse, but harmful to those who have not yet developed many of the secondary symptoms. **Kaolin** is the remedy of choice if the patient does not come under treatment too late. In persons over 50 years of age the prognosis is poor in any case. Women are more severely affected than men. Braafladt (China Med. Jour., May, 1920).

The writer extols the treatment of cholera by intravenous injection of physiologic **saline solution**, plus 5 per cent. **sodium bicarbonate solution**, in equal amounts, 100 c.c. ( $3\frac{1}{2}$  ounces). The quantity for 1 injection is determined by observing the recovery of the patient from cyanosis. Several thousand c.c. may be injected at 1 treatment. Ichikawa (Japan Med. World, Sept. 18, 1920).

Administration of **kaolin** by mouth in large amounts found of value when begun early in the disease. Its advantages are, the simplicity of the method, absence of relapse, cessation of loss of fluid, rapid removal of the general toxic state, early return of the ability to pass urine, and early and rapid convalescence. The quantities of kaolin given are such as to almost fill the bowel. It forms an adherent coating on the bowel walls and carries with it a large number of bacilli, necessitating destruction of the feces when they are passed, as usual. R. R. Walker (Lancet, Aug. 6, 1921).

Describing an epidemic at Tzeliut-sing, China, the author notes that some earth rather like kaolin, though lighter in color and with greater absorbing power, was made up in 3 ounce powders and distributed to schools and chapels. There were in-

stances of cures claimed for the kaolin. Altogether, 231 cases were treated, with a mortality of 28.7 per cent. Of various kinds of medicines tried, a commercial **cholera mixture** gave the best results. For intense thirst, a weak solution of **potassium permanganate** was given. **Massage of the legs**, especially the calf, proved subjectively helpful. Wallace Crawford (China Med. Jour., Sept., 1921).

Series of 97 cases treated with a mortality of 20.5 per cent. The intravenous injections were started with a solution of **sodium bicarbonate**, 2 drams (8 Gm.) to 1 pint (475 c.c.) of water, followed by the usual **hypertonic solution** of Rogers. The first solution minimizes lung disturbance, overcomes acidosis more quickly than Rogers's hypotonic solution, and promotes diuresis. Drug treatment consisted of 1 of the following powders every half hour until the disease was arrested: **Calomel**,  $\frac{1}{4}$  grain (0.008 Gm.); **camphor**, 2 grains (0.12 Gm.), and **sodium bicarbonate**, 10 grains (0.6 Gm.). Vomiting yielded rapidly to the fractional doses of calomel. The remaining medicinal measures were those laid down by Rogers. Hypodermic injection of **pituirrin** was found effective where, during saline infusions, a vasomotor condition set in which blocked the entrance of fluid. Chatterjee (Indian Med. Gaz., Jan., 1922).

Sajous has pointed out that the symptoms of Asiatic cholera—hypothermia, frigidity, cyanosis, profound asthenia, and low vascular tension—correspond to those of adrenal failure. During the Balkan and World Wars various clinicians found that **adrenalin** in large and frequently repeated doses not only antagonized the effects of the cholera toxin, but soon arrested the characteristic symptoms of adrenal failure. The choleraic diarrhea of soldiers, following great fatigue, was likewise promptly arrested by the same treatment. F. E. Stewart (Amer. Med., Jan., 1922).

Prophylactic as well as curative value is ascribed by the writer to a

mixture of **spirits of ether**, oil of **cloves** and oil of **cajuput**, of each 30 minims (2 c.c.); oil of **juniper**, 5 minims (0.3 c.c.), and **aromatic sulphuric acid**, 15 minims (1 c.c.). One dram (4 c.c.) of this in  $\frac{1}{2}$  ounce (15 c.c.) of water is taken every  $\frac{1}{2}$  hour until vomiting and purging cease. As a preventive among contacts, the same dose is taken once or twice daily for 1 or 2 days. J. W. Tomb (Indian Med. Gaz., June, 1923).

Gratifying results with **cresol** in a cholera outbreak in 1923. The patient is at once given 1 to 4 minims (0.06 to 0.25 c.c.) of **cresol**, according to age and size, dissolved in a like number of ounces (30 c.c.) of tepid water. This is repeated every  $\frac{1}{4}$  hour for a couple of hours, the interval being then increased to  $\frac{1}{2}$ , 1, 2 hours, etc., while at the same time the dose is slightly reduced. As the symptoms subside, small amounts of **tepid water** are given in the intervals. For excessive vomiting **morphine**,  $\frac{1}{4}$  grain (0.015 Gm.), is given hypodermically, or **tincture of opium**, 20 to 30 minims (1.3 to 2 c.c.), may be given with a 1st small dose of **cresol** and the dose increased to 3 or 4 minims (0.2 to 0.25 c.c.) if the 1st dose is not quickly rejected. In dry cholera, **magnesium sulphate**, 1 ounce (30 Gm.), dissolved in water, 2 ounces (60 c.c.), and containing **cresol**, 5 minims (0.3 c.c.), may be given as an initial dose. As the patient improves, 2 to 3 minims (0.12 to 0.2 c.c.) of **cresol** in water are given twice daily to lessen the tendency to the carrier state. After the attack great care in **diet** for some days is required, proteins being added only very cautiously. In cases with marked cerebral symptoms **tube feeding** from the start is indicated. Among 61 cases of cholera thus treated the mortality was 19.6 per cent. F. J. Palmer (Indian Med. Gaz., Aug., 1924).

Combined use of **kaolin** and **potassium permanganate** favored in cholera treatment. Chatterjee (Indian Med. Gaz., Nov., 1924).

A considerable reduction of mortality has been obtained with Leonard Rogers's procedure of giving a **hypertonic saline solution** intravenously. A suspension of **kaolin**, taken in large quantities, is stated to have given good results.

In the presence of an epidemic it is especially necessary, in so far as is possible, to avoid fatigue, worry, fear, and injudicious dieting. Alcohol, unboiled water, purgatives, and the use of uncooked food and especially foods prone to decomposition, as crabs and shellfish, must also be avoided. The use of vaccines has already been alluded to. No serum has thus far been produced which will yield definite results.

### INTESTINAL INFARCTION (Including Embolic and Thrombotic Obstruction of the Mesenteric Arteries and Veins).

In acute endocarditis, and even in the course of chronic endocarditis, infarcts are not uncommon, particularly in the spleen and kidneys; less often they occur in the brain, not seldom in the lungs, and occasionally few or numerous ones are found in the intestines. In recent cases the infarcted area is apt to suppurate because of the mycotic emboli; thus, numerous miliary abscesses may occur. Embolism of the mesenteric arteries, usually the superior, may occur in arteriosclerosis, aneurism, or endocarditis, and an ischemic process or hemorrhagic infarction of the small intestine follows. Thrombi may form in the mesenteric veins either as a result of a general infection or occasionally in intestinal ulcers or appendicitis, and especially in that severe complication of the lat-

ter condition, namely, pylephlebitis. They may also form in hepatic cirrhosis, in the cachexias, the grave anemias, and after embolism. Rarely, when the involved area is small, a collateral circulation may be established, but in the majority of instances gangrene results.

Case of embolism of superior mesenteric artery in which death occurred before the intended operation could be performed. The superior mesenteric artery was occluded at a point between the colica media and colica dextra. The portion of the duodenum supplied by the gastroduodenalis was not involved, but the entire small intestine except the duodenum was gangrenous. F. A. Carmichael (Jour. Amer. Med. Assoc., Feb. 26, 1910).

Case of anemic infarct of the small intestine in a man of 70. The arteries of the intestine showed an old obliterating endarteritis that had caused an acute thrombosis. The veins showed a similar condition. W. R. Meyer (Centralbl. f. allg. Pathol. u. pathol. Anat., March 15, 1913).

In thrombosis of the mesenteric artery **purgation** will always produce an effectual result, thus ruling out intestinal obstruction. Report of a case of pancreatitis with thrombosis of the mesentery and accompanying gangrene of the gut. There was no suspicion of previous endocarditis. Extravasation of fluid with pancreatic enzymes into the peritoneal cavity during the recurrent attacks of pancreatitis may have led to destruction of mesenteric tissue, with resulting mesenteric thrombus. Ernest Laplace (Penna. Med. Jour., June, 1913).

The symptoms are of sudden onset, consisting of abdominal pain, nausea, vomiting, and bloody flux or obstinate constipation, with abdominal distention and collapse. Death usually follows in from one to three days.

Suggestion that thrombosis may occur in the small vessels of the mesentery at least as often as in the large. Report of several cases. Stalley (St. Paul Med. Jour., Aug., 1913).

Mesenteric vascular occlusion is not an extremely rare condition. The writers who report 3 cases, found about 400 recorded in the literature. The occlusion is most frequently in the arteries. By far the most common lesion produced is hemorrhagic infarction of the intestine. The most common cause of the occlusion is embolism resulting from infection and injury. There is no difference clinically between the arterial and the venous occlusion, regardless as to whether it is due to embolism or thrombosis, in the superior or the inferior vessels. The clinical diagnosis should be made on sudden onset, acute colic-like abdominal pain, distention and tenderness, signs of shock and collapse; often there may be vomiting and constipation; if diarrhea is present, it is almost always accompanied by melena. Eisenberg and Schlink (Surg., Gynec. and Obstet., July, 1918).

The diagnosis is always difficult, but may be aided by the recognition of the various possible etiological factors, in the absence of which a diagnosis of acute pancreatitis or intestinal obstruction is usually made.

Case of thrombosis of the superior mesenteric artery simulating an abdominal tumor. A man aged 67 years was admitted for urinary disturbances due to an enlarged prostate. Later he had a suppurative orchitis and perineal abscess. About a month later, during dressing of the wound, he was seized with violent pain located below the false ribs, and radiating to the sternum and lower limbs. There was no nausea or vomiting, no stool since the night before, and no tympanites. At the site of greatest pain, a movable mass the size of two closed hands was palpated. Its dullness was continuous with that

of the liver. On the third day death occurred. At autopsy there was found a mass of intestinal loops violet black in color and distended. In a branch of the superior mesenteric artery was found a grayish adherent clot. Thévenot and Rey (*Arch. gén. d. chir.*, v. 1234, 1911).

The sequence of the two contradictory symptoms, diarrhea and ileus, is of diagnostic import in mesenteric embolism. In the author's case the chief complaint was an obstinate fetid diarrhea.

Eleven of 24 patients with mesenteric embolism recovered after **enterectomy**—45.8 per cent. The author encountered a number of cases of "curable" intestinal embolism in debilitated men with pneumonia or bronchitis. The edema and small infarcts in these cases are liable to subside spontaneously, but they are probably the source of sclerous stricture of the intestine, and probably of the pains in intestinal arteriosclerosis. E. Boinet (*Bull. de l'Acad. de Méd.* Jan. 16, 1912).

Three cases of vascular occlusion of the mesenteric vessels. The occlusion is practically always in some part of the superior mesenteric. Occasionally an embolus or thrombus may cause no apparent symptoms, on account of the establishment of collateral circulation. Intestinal obstruction may also occur without infarction, the blood-supply being sufficient for nutrition of the bowel, but not for function. The author's cases followed operations for acute suppurative or subacute peritonitis, and all ended fatally in spite of operation. The patients became violently ill—2 on the sixth and the other on the ninth day after the operation for peritonitis. One of them had 1 large and several smaller infarcts. J. W. Tankersley (*Va. Med. Mthly.*, Apr., 1923).

Case in a man who had previously had symptoms of intermittent claudication and later angina pectoris. He finally died from intestinal infarction. Symptoms of intestinal arteriosclerosis (paroxysmal abdominal pain, colic

stasis) had not occurred, but the diagnosis of mesenteric thrombosis was made during life on the basis of an acute peritoneal syndrome and the long history of atherosclerosis with arterial clinical manifestations. At autopsy the aorta, coronary, iliac, femoral and mesenteric arteries all showed sclerosis. A. Cawadias (*Lancet*, May 12, 1923).

Unless operative **resection** is feasible, death is inevitable, and in the septic cases it is practically inevitable in any event.

Case of mesenteric occlusion in a boy of 15 who four days before had sustained a hard blow in the stomach. Resection of 40 inches of the infarcted intestine was accomplished by **end-to-end anastomosis** with **Murphy button**. The patient recovered and was well thereafter, excepting for a slight tendency to diarrhea. E. C. Thompson (*N. Y. State Jour. of Med.*, April, 1911).

In 11 of 14 cases of mesenteric vascular occlusion in the Johns Hopkins Hospital records intestinal infarction was produced; in the other 3, sufficient collateral circulation developed to prevent it, and the condition was found at necropsy. In 13 cases the superior mesenteric vessels were involved, in 1 the inferior. The arteries were involved in 4 cases, the veins in 8. Of the 11 cases with infarction, 8 ended fatally; 5 of 8 patients treated by laparotomy died. Intestinal anastomosis should not be performed at the primary operation. In the author's case, which recovered, the infarcted intestine with about 2 inches of good bowel at either end was resected through a low midline incision; the 2 ends were temporarily closed and brought out through a short McBurney incision on the side opposite that on which the **enterostomy** opening was to be. At the second operation an incision was made around the enterostomies and a resection and **lateral anastomosis** performed. L. Brady (*Arch. of Surg.*, Jan., 1923).

The operative prognosis in limited intestinal infarcts due to partial occlusion of the mesenteric artery has improved in recent years, probably because of earlier operation in acute abdominal conditions. Flint's statistics of 49 recoveries in 58 resections of segments of the small intestine over 200 centimeters (78 inches) long justify, at least theoretically, resections involving up to  $\frac{1}{2}$  of the small intestine. Desplas (Bull. Soc. nat. de chir. de Paris, Mar. 15, 1924).

## INTESTINAL ULCERS.

Ulcers may occur in any portion of the intestine, from duodenum to rectum, and vary in gravity from the simple follicular ulcers already mentioned under catarrhal enteritis to the extensive sloughing ulcers of dysentery. They may be single, as is usually the case in the duodenal ulcers, or multiple,—even confluent,—and vary in their site according to the condition producing them. They vary also in their course, being acute or chronic according to the nature of the cause.

Case of perforated jejunal ulcer, one year after a posterior gastro-enterostomy for perforated duodenal ulcer. Symptoms had begun 7 months after the gastroenterostomy, with periodic attacks of generalized abdominal pain occurring every 3 days and lasting 10 to 15 minutes without relation to food. Gradually the pain became localized 1 inch below the umbilicus and began to come on about 4 hours after a meal, lasting till the next. It was relieved by self-induced vomiting. At operation the perforated ulcer was found on the posterior wall of the efferent loop of the gastroenterostomy coil of jejunum about  $1\frac{1}{2}$  inches from the stoma. It was enclosed by a **purse-string suture**. The pylorus being patent, an **entero-enterostomy** between the afferent and efferent loops of the gastroenterostomy loop of jejunum was performed. Three months later,

symptoms returned. Upon laparotomy, a second jejunal ulcer was found close to the gastroenterostomy stoma. A partial gastrectomy involving  $\frac{3}{4}$  of the stomach and the whole of the loop of jejunum taking part in the gastroenterostomy was performed. Complete recovery followed. Ashcroft (Brit. Med. Jour., Mar. 20, 1926).

## DUODENAL ULCER.

**DEFINITION.**—An ulcer usually in the first or second portion of the duodenum, small, round, ovoid, or occasionally irregular in outline, with a tendency to perforate, and in many instances markedly chronic in course. This ulcer essentially belongs to the type known as peptic ulcers.

**SYMPTOMS.**—Until recent times this condition was overlooked.

[According to Mr. Moynihan, duodenal ulcer was first recognized by Mr. Travers, whose first cases were published in 1817. Abercrombie seems to have been the first to suggest the possibility, during the life of the patient, of the recognition of duodenal ulcer. The first case of perforating ulcer of the duodenum successfully treated by operation was reported in the British Medical Journal by Mr. H. P. Dean, in 1894. Moynihan's first case was operated on in June, 1900.]

Both gastric and duodenal ulcer are especially prone to occur in people with a family predisposition to tuberculosis. Though manifesting no definite evidence of tuberculosis themselves, their history and physical conformity lead one to regard such cases at least as suspects.

Of 486 cases with duodenal lesions, six were cancerous and 480 were benign ulcers, a ratio of 1 to 80. In a series of 780 patients with gastric lesions 240 were found to be cancerous and 540 were benign, a ratio of 1 to  $2\frac{1}{4}$ . The writer had 6 cases of carcinoma of the duodenum, and about 240 cases of carcinoma of the stomach, a ratio of 1 to 40, largely verified



by necropsy or operation. In a series of peptic ulcer cases, duodenal ulcer had been diagnosed 480 times and gastric ulcer 540 times. J. A. Lichty (N. Y. State Jour of Med., Nov., 1918).

According to Moynihan, there are few diseases in which the symptoms appear in such definite and well-ordered sequence. He admits that in some cases the usual order of symptoms fails, or that occasionally, on account of the exaggeration of one symptom, the value of the others may be dwarfed or destroyed, but this he regards as exceptional.

Of great importance is the history, as already stated. The patient will usually complain also of symptoms which he speaks of as indigestion, acid dyspepsia, or sour stomach, and very suggestive is the statement that this has lasted over some years, with alternate improvement and relapse. Moynihan insists that these symptoms are apt to be more marked and occasionally only present during the cold, damp seasons. During the active periods of the ulcer, according to him, the most important diagnostic feature is the so-called "hunger pain." This was first noted by John Abercrombie, in 1830. In some instances this is extremely marked, pain coming on from two to four hours after a meal and being relieved by the taking of food. If the diet be light, and especially if it is liquid, pain is apt to occur earlier; the converse of this is likewise true.

When a duodenal ulcer has undergone cicatricial contraction, the symptoms are those of retention and delayed motility, proportionate to the stenosis and duration of the lesion. On this point Hertz, in his little work on the "Sensibility of the

Alimentary Canal," makes the following statement:—

"Frequently, but by no means invariably, an ulcer near the cardia gives rise to pain immediately after meals and an ulcer near the pylorus about an hour and a half to two hours after meals, intermediate situations being associated with intermediate times. The time of onset of pain in duodenal ulcer is much more constant; it almost always begins between two and three hours after a meal. The time relations can be explained by considering at what moment free hydrochloric acid comes into contact with the ulcer so as to lead to an exaggeration of the reflex motor efforts which produce pain. The hydrochloric acid is secreted mainly by the glands of the proximal two-thirds of the stomach, the secretion of the extreme pyloric end being actually alkaline. As no peristalsis and consequently no churning of the contents occur in the fundus, the outer layer of chyme remains constantly very acid. A cardiac ulcer is therefore bathed in acid gastric juice at a very early stage in digestion. The food which first reaches the pyloric end of the stomach is alkaline; it is only after a considerable interval that the acid gastric juice reaches this part to any great extent, and as peristalsis is constantly active in the pyloric part, the gastric juice is greatly diluted by the large quantity of food with which it is mixed. Consequently an hour or more may pass before there is sufficient free acid to irritate an ulcer near the pylorus."

In only 123 of the author's 160 cases of chronic duodenal ulcer were the symptoms characteristic; the others suggested gall-stone trouble or gastric

ulcer. Hunger pain was present in all but 20 of 146 cases; in the intervals the patients felt entirely well. Anger, chilling, and overwork are liable to bring on an attack. In one group there was absolutely no pain at any time, the symptoms consisting merely of attacks of dilatation of the stomach with vomiting, alternating with intervals of complete health. There was excess of free acid and the total acidity was high; the opposite is the rule in cases with similar symptoms due to gall-stone or coprostasis. J. Sherren (*Berl. klin. Woch.*, July 14, 1913).

The finding of occult blood in the stools of patients with a suggestive history warrants a diagnosis of duodenal ulcer. Extraintestinal sources of bleeding must be ruled out, as hemorrhoids and vaginal discharges in women. The writer gives a list of 32 cases where a diagnosis was made on occult blood findings in the feces and where the diagnosis was confirmed at operation. The examination of the stools should include the guaiac test, the benzidin test, spectroscopic search for hematin, and microscopic search for hemin crystals. A. J. P. Pacini (*Med. Record*, Dec. 1, 1917).

The writer calls attention to the frequent co-existence of appendicitis with gastric and duodenal ulcers. In 36 laparotomies for ulcers and pyloric stenosis, the appendix was found diseased in 12 cases (33 per cent.); 18 out of 40 cases operated upon for juxtapyloric or duodenal ulcers showed chronic appendicitis (45 per cent.).

The author also observed that about 80 per cent. of his gastric ulcer patients were seized with pulmonary tuberculosis, generally benign and of slow evolution.

Almost every patient presented what the author calls the "pneumogastric sign," i.e., pain on pressure at the level of the cervical pneumogastrium. He infers that this is a neuritis of the vagi nerves of pulmonary origin, originating from the gastro-

intestinal distribution of these nerves, which causes trophic disturbances and thence ulcers and other chronic inflammatory injuries of the intestinal tract. Dubard (*Lyon chirurg.*, xv, 356, 1918).

Among the obscure and incomplete forms of duodenal ulcer, cases presenting jaundice occur not infrequently. Thus, in a man of 37 years, in whom progressive icterus of the catarrhal type was followed by fatal intestinal hemorrhage, 3 duodenal ulcers were discovered at the autopsy. In this case jaundice constituted the only sign, the history being negative and pain and the other signs of ulcer, absent. Ulcer accompanied by jaundice is often, though not invariably, located near the opening of the common duct into the duodenum; obstructive jaundice especially suggests this location. In doubtful cases the diagnosis must rest on close study of the history and symptoms, examination of the feces and duodenal contents, and serial roentgenography. G. Bickel (*Arch. des mal de l'app. dig.*, Nov., 1923).

During the active phase also, the patient is likely to complain of a sense of epigastric oppression, weight, and distention, especially an hour or more after the taking of food. Duodenal cases are prone to manifest nervous phenomena similar to those with which we are familiar in cases of hyperchlorhydria, viz., insomnia and general irritability. Loss of weight may occur. Owing to the fact that the pain comes on some time after a meal, it is not unusual for these patients to take a light meal at bedtime or to keep biscuits at the bedside. Relief is often obtained by abdominal pressure; hence the tendency to lie in a prone position. The appetite is, as a rule, very fair, often good. Nausea and vomiting are the exception. During the quiescent period, which may

extend over weeks, months, or even several years, absolutely no symptoms may be complained of. Suddenly there may be a return, and occasionally the vomiting of blood, or tarry stools, or evidences of perforation may announce the advent of serious complications.

Moynihan's description of the symptoms of duodenal ulcer was as follows: The patient states that he has certain definite attacks, nearly always worse in winter than in summer, and very apt to be precipitated by a chill. From two to two and a half hours after breakfast he is fairly comfortable. It is his best time. Then he has a feeling of discomfort in the epigastrium; he feels full and heavy, and may get some relief from the belching of gas. Some of these patients bring up a very sour fluid, which tastes very bitter and acid and makes the mouth dry and the teeth chalky. This pain gradually increases until the next mealtime comes. The patient sleeps comfortably until he wakes about 2 A.M. He gets relief from nibbling a biscuit, which he keeps at the bedside. The pain is found to be most relievable by something stodgy and indigestible. Taking an alkali relieves the pain; so will emptying the stomach by washing it out. If these symptoms are recurrent one can diagnose duodenal ulcer.

In the presence of a duodenal ulcer near the pylorus, if the patient drinks a pint of milk during the attack of pain the latter keeps up in the same intensity for five, ten, or fifteen minutes; then suddenly the patient belches some gas and in a minute the pain is over. This occurs regularly. When the ulceration is in the stomach itself, the patient feels relief of the pain after a few swallows of milk and gradually all pain subsides. With duodenal ulcer, röntgenoscopy shows that the pain ceases as the milk passes into the duodenum. Meunier (*Presse méd.*, Feb. 7, 1912).

Heartburn and water-brash were present in 23 per cent. of the author's patients. Tobacco is a prominent cause of these symptoms. Pain is absent in 10 per cent. of duodenal

ulcer cases, may be atypical (not related to food), or may conform to the typical hunger pain. Increasing experience confirms the conviction that several factors are involved, *viz.*, mechanical, vascular and neuromuscular factors. Vomiting, which occurred in 67 per cent. of the cases, was twice as frequent in the stout and medium types of patient as in the thin type. Hematemesis, which occurred in 17 per cent. of the cases, was present in 30 per cent. of stout subjects (large ulcer), 18 per cent. of medium subjects, and in only 7 per cent. of the thin type (small ulcer). H. T. Gray (*Brit. Med. Jour.*, June 14, 1924).

The patient with duodenal ulcer has no dread of eating; on the contrary, he usually has a good appetite, is prone to eat freely of all kinds of food, and often looks robust and even over-nourished. Periodicity of the pain with seasonal recurrence is much commoner in duodenal than in gastric ulcer. Nausea and vomiting are commoner in gastric than in duodenal ulcer. L. F. Barker (*Jour. Amer. Med. Assoc.*, Oct. 31, 1925).

**DIAGNOSIS.**—Physical examination of the abdomen in all cases presenting gastric or intestinal symptoms deserve very much more attention than has hitherto been given to it. Its actual value can, of course, only obtain confirmation when symptoms, reflex phenomena, and the lessons learned by operative interference are carefully correlated, or, in addition, by the findings at necropsy.

According to Günzburg, the enlargement of the duodenum in duodenal ulcer is apt to induce a characteristic tympanitic percussion sound over the quadrate lobe of the liver. This is caused by the dilated duodenum passing behind this lobe. It appears only when the liver is in its normal place and when the dullness over the left lobe of the liver can be distinguished from the cardiac dullness. The colon must be emptied before percussing.

The clinical diagnosis of duodenal ulcer has been chaotic until recently. The change of opinion as to the frequency of duodenal ulcer has been very remarkable during the last 2 years. Most of the ulcers in the vicinity of the pylorus which had been called pyloric ulcers are in reality duodenal. Gastric ulcers in the terminal  $1\frac{1}{2}$  inch of the pylorus may be mistaken for carcinoma on account of the tumefaction due to edema and muscular hypertrophy. The writer's statistics show 73 per cent. duodenal ulcers to 27 per cent. gastric ulcers. In typical duodenal ulcer the history is the most important diagnostic feature, the roentgenogram second, the physical diagnosis including the use of the stomach tube third, and the laboratory diagnosis a poor fourth. W. J. Mayo (Med. Rec., June 12, 1915).

There is present in all cases of duodenal ulcer, just to the right of the linea alba, slightly below the mid-point between the costal arch and the umbilicus, a tender spot, usually the size of a 50-cent piece, which is painful on the slightest percussion. The area grows smaller as the ulcer heals and finally disappears. Mendel (Deut. med. Woch., Apr. 15, 1920).

According to MacKenzie ("Interpretation of Symptoms"), owing to the autonomic cerebrospinal reflex, one finds cutaneous hyperesthesia, hyperalgesia, and more or less muscular rigidity, occurring in the mid-line between the xiphoid and umbilicus, in all active cases of gastric and duodenal ulcer. He further states that in ulcer of the cardia these phenomena, more or less marked, occur at the upper extremity of the xipho-umbilical line. In ulcers in the median portion of the stomach they are lower down, in pyloric ulcer still lower, and in ulcers of the duodenum these reflex signs are just above the umbilicus. To elicit them, one should

be extremely light of touch, as a heavy hand results in the production of rigidity and more or less discomfort even under normal conditions, though, of course, without cutaneous hyperesthesia or actual hyperalgesia (the latter being examined for by pinching the skin).

The laboratory findings are not of very great value in the diagnosis of this condition. Hyperacidity and excess of free hydrochloric acid may be present in several states other than ulcer, and in ulcer the findings may be normal or even subnormal as to acidity, total or free. Hypersecretion may likewise be present. When hyperacidity occurs, however, it is most apt to be present in the acute phases.

In suspected ulcer, an accumulation of anamnestic, general physical, roentgenologic and clinical chemical data should be studied before reaching a conclusion. The physical examination is more helpful in ruling out simulating conditions. Not too much weight should be attached to the stomach contents. Gastric hyperacidity is usually marked in about  $\frac{3}{4}$  of the cases of duodenal ulcer, as against  $\frac{1}{5}$  in gastric ulcer; but the acidity conditions, even on fractional analysis, are very variable in both of these disorders.

Examination of the feces for occult blood after 3 days of hemoglobin-free diet is a valuable technical method, but absence of blood does not exclude ulcer. An anemia of secondary type with marked hemoglobin reduction may give the clue to repeated small hemorrhages from ulcer.

The so-called premonitory signs of ulcer perforation (feeling of bloating, feeling of intestinal blockage, symptoms of localized peritonitis) should be kept in mind, but these symptoms are only rarely sufficiently distinctive for prophylactic guidance. L. F. Barker (Jour. Amer. Med. Assoc., Oct. 31, 1925).

As to the value of X-ray examinations, I quote again from Hertz: "In a series of cases of duodenal ulcer examined with the X-rays, I have always found that the stomach begins to empty itself immediately after the food has been swallowed and that the evacuation is at first rapid. When the pain begins between two and three hours after a meal, only a small proportion of the food is still present in the stomach, and the hypertonic condition constantly present in cases of duodenal ulcer reaches its greatest development, owing to the increase in tone which occurs as the bulk of the gastric contents diminishes. Under these conditions peristaltic contractions can produce a complete separation of the pyloric part from the rest of the stomach at a considerable distance from the pylorus. Owing to the excessive and prolonged secretion of normal gastric juice, which is the cause of the so-called hyperchlorhydria of duodenal ulcer, the proportion of gastric juice and of hydrochloric acid in the chyme increases as digestion proceeds. At first most of the acid combines with alkaline salts and the proteins of the food, and the small quantity of free acid which reaches the duodenum is rapidly neutralized by the alkaline intestinal juice, bile, and pancreatic juice, so that the relaxation of the pylorus is only occasionally inhibited. But after two or three hours, the proportion of acid present being greater, some of it reaches the ulcer before it is neutralized. The inhibition of pyloric relaxation, which the contact of acid with the intact duodenal mucous membrane produces, is exaggerated by the presence of the ulcer, so that the peristaltic waves advance

against a pylorus, which only opens at considerable intervals in order to permit the passage of a small quantity of hyperacid chyme into the duodenum. Immediate relief to the pain follows the administration of alkalies or proteins, which neutralize the acid, or of food or water, which dilutes it; relief is also produced by vomiting and lavage, which remove the acid and at the same time empty the stomach so that nothing is left upon which the muscular coat can contract. The pain disappears spontaneously only when the stomach has become completely empty. This generally occurs about an hour after onset of pain, but if the evacuation of the stomach is hindered by partial obstruction due to cicatrization or inflammatory swelling round the ulcer, the pain lasts for many hours. As the sense of fullness is produced by exactly the same mechanism as pain, when the stimulus is less powerful, a sensation of fullness is generally felt between two and three hours after food for some months before the first occurrence of pain. At a later stage pain may be replaced by this sensation after some meals, and, as Moynihan has pointed out, the characteristic hunger pain is preceded and accompanied by a sensation of fullness, distention or weight in the same situation. I have already explained how the patient often erroneously ascribes this to flatulence and repeatedly tries to eructate, temporary relief being at last obtained by the return of some of the air swallowed in the preceding unsuccessful attempts. The salivation which often occurs when the pain is most severe is an additional cause of the aërophagy."

In general, X-ray examination has assumed great importance for confirming the diagnosis, and serves to amplify the diagnostic data. Competent interpretation of the pictures is, however, a pre-requisite to dependable information from this source.

In only 23 of a series of 522 cases operated with an X-ray diagnosis of duodenal ulcer was ulcer not found; in all but 1 of these the condition found was one requiring operation. On the other hand, out of 544 cases in which diagnoses other than ulcer had been made, 32 proved on operation to have ulcer. R. D. Carman (Jour. of Radiol., May, 1922).

In 30 cases, a niche was the most constant X-ray finding. A duodenal defect is most often functional and seldom represents the ulcer base, being usually opposite to it. Giving belladonna for 48 hours, with a milk diet, increases the number of visualized niches. J. S. Diamond (Amer. Jour. of Roentgenol., Apr., 1924).

The routine X-ray study at the Mayo Clinic comprises a bariumized carbohydrate meal to test motility and a screen examination 6 hours later, at which time an aqueous suspension of barium is given. The X-ray evidences of duodenal ulcer are: (1) Direct duodenal signs; (2) indirect signs, all of which are gastric. Direct signs comprise: (a) the niche, *i.e.*, the visualized crater of the ulcer, and (b) bulbar deformity without a niche. Usually, in the latter case, the niche is too shallow to be visible. The niche is seldom large, and is often extremely small. Niches are most likely to be found on the mesial border of the bulbar shadow. A niche is generally accompanied by organic or spastic deformity, either in its vicinity or on the opposite border of the bulb. A niche is not essential for diagnosis, unless no other deformity exists.

Constant deformity of the bulb is the mainstay of diagnosis. At times, cicatricial contraction is largely responsible for it; but, as a rule, it is

dominantly spastic and often entirely so. The distortion takes a multitude of shapes. The bulbar shadow may be deformed on one side alone, commonly the mesial side, or on both aspects, or only at the base.

As for the indirect signs of duodenal ulcer, gastric hypertonus is a common feature of non-obstructive ulcer. When obstruction occurs the stomach loses its tonicity and becomes enlarged. Hyperperistalsis occurs often. When obstruction is marked, antiperistaltic waves may be visible. Hypermotility, shown by an advanced position of the motor meal, occurs frequently. Gastrosplasm shows an incisura or an antral deformity. When bulbar deformity is demonstrable, the aid of these secondary signs is not needed. But in marked obstruction, where it is hard to fill the bulb for demonstration, the combination of a large stomach of normal contour with hyperperistalsis and a 6-hour retention is quite as diagnostic of duodenal ulcer as is bulbar deformity. Carman (Jour. Amer. Med. Assoc., Oct. 31, 1925).

Anemia and occult bleedings are capable of recognition by examination of the blood and stools. This should never be overlooked. Hematemesis and melena must be looked upon as late phenomena and essentially complications.

If hunger pain is present in an individual who is irritable, with more or less insomnia, a history of acid eructations, and especially if occult blood is found in the stool, the diagnosis is comparatively simple. In long-standing cases symptoms may be absolutely quiescent for a greater or less length of time, after which hemorrhage, melena, or perforation suddenly develop. The age—the condition being most common between 30 and 50.—and the ancestral and collateral tuberculous history are likewise factors of importance.

According to Codman, jaundice occurs in a considerable number of cases of duodenal ulcer, usually in transient attacks, probably due to inflammation of the mucous membrane of the duodenum started up by the presence of an ulcer. Vomiting is somewhat characteristic. It is noted only in the acute attacks when the pylorus is temporarily disabled. When cicatricial obstruction occurs it corresponds to the type of obstruction, whatever be its cause. The vomiting during the acute attacks lasts but a few days, comes on at the height of pain, and the vomitus shows complete digestion. Only in case of associated obstruction does it show the presence of food taken at a long interval before. Cases diagnosed as gastric ulcers which give a history of pain and distress off and on for a long time before vomiting begins to be a symptom, are almost always duodenal. Long-continued, painful dyspepsia, with occasional attacks of pyloric symptoms, is the important combination to look for in duodenal cases.

Report of 5 cases of *duodenal perforation*. Each occurred in a man in the prime of life and each patient had been in good health up to the time of the disaster. Previous indigestion is unusual in duodenal ulceration. This symptom never has the same prominence as in cases of perforated gastric ulcer. The onset of pain is sudden and entirely without any exciting cause. Gentle palpation reveals the upper part of the right rectus a little more tense than the corresponding part on the left, while there is a definitely tender spot above the umbilicus and to the right of the middle line. A new and misleading symptom then appears, the patient complaining of pain in the right iliac fossa. Many cases of acute duodenal perforation are thus diagnosed as acute appendicitis. This may be avoided if one remembers that in acute appendicitis the pain, tenderness, and rigidity are limited to the lower part of the abdomen. Another misleading feature in acute duodenal perforation is the subsidence of the abdominal symptoms as the initial shock passes off. D'Arcy Power (Lancet, July 13, 1912).

Tumors or ulcer in the body of the stomach may induce symptoms simulating those of duodenal ulcer. Determination of the exact site of the pain is quite important as well as the way in which the pains radiate. They extend to the left more with gastric ulcer, while the radiation is toward the right shoulder and arm and liver region with ulcers near the pylorus or in the duodenum. There was no pain on pressure in 20 per cent. of the author's duodenal cases, in 9 per cent. of pylorus ulcers, and in 10 per cent. of gastric ulcers, but there was diffuse tenderness in the epigastrium in 25, 27, and 40 per cent., respectively, and circumscribed tenderness below the xiphoid process in 10, 18, and 20 per cent., respectively. A. Sommerfeld (Arch. f. Verd., Feb., 1913).

The periodicity of the symptoms of duodenal ulcer is a valuable diagnostic feature. The attacks, moreover, occur mainly during the cold season, or at most, during the spring and fall, while the symptoms from gastric ulcer appear at irregular intervals. The duodenal ulcer patients are often entirely free of symptoms, while in gastric ulcer dyspeptic symptoms very often persist. Schutz (Wiener klin. Woch., Apr. 15, 1920).

In simple ulcer remote from the pylorus, the writer stresses the evolution by successive attacks rather than the late pain. The appetite remains good, and the pain at night, starting in the right hypochondrium, is not associated with vomiting. Aside from contraction of the right rectus, occult bleeding, and hyperchlorhydria, he emphasizes the import of a tender point on the left side of the neck, and tenderness of the duodenum when it is forced against the rear wall of the abdomen by palpation along a line connecting the tenth rib with a point at the center of a line connecting the iliac crests. Another sign is relief of the pain on deep inspiration.

The giving of an enema of antipyrin and laudanum would eliminate the tender points due to the gall-bladder

or to celiacgia. Parturier (Progrès méd., Oct. 22, 1921).

Ascites may occur in duodenal ulcer because of pressure on the portal veins by inflammatory tissue, and does not necessarily mean malignant degeneration of the ulcer. Such ascites is rare, however, in the absence of associated hepatic cirrhosis. An exploratory operation should be done in ulcer with ascites, even if the chances are in favor of malignancy, since it is possible that simple ulcer may be found. Upon surgical exclusion, the ulcer rapidly retrogresses and the ascites permanently disappears. Finsterer (Internat. Clin., iv, 154, 1921).

Differential diagnosis between duodenal ulcer and *hyperacidity with gastralgia*: Whereas in ulcer there are emaciation, pallor and weakness, in hyperacidity the general health is little affected. In hyperacidity the gastralgia remains unchanged for years, while in ulcer the intervals of freedom from pain grow shorter and the nocturnal pains more severe. In hyperacidity, withdrawal of the foods exciting marked secretion and substitution of a milk and vegetable diet overcome the pain, while in duodenal ulcer this is much less the case, and rest and a milk diet are especially required. Even the occurrence of hemorrhages does not preclude the existence of gastralgic hyperacidity. Boas (Arch. f. Verdauungsk., Jan., 1923).

**ETIOLOGY.**—Duodenal ulcer was long considered to be much more common in men than in women, and even relatively recent statistics showed ratios of about 4 to 1 in this connection. The ratio has, however, been gradually declining, and the older view has largely given way to that of an approximate equality of incidence in the two sexes.

As to age, duodenal ulcer may occur in any period of life, being most common, however, between the ages of 30 and 50 years. T. D. Lister reported a case of duodenal ulcer in a

child 3 days old, and Spiegelberg, one in a child 5 days old. A number of other cases occurring within the first few days of life, clinically characterized as cases of melena neonatorum, have been reported. These have been shown to be due to infection, probably through the umbilicus.

Case of duodenal ulcer in a child of 2 months. From the first the child had been difficult to rear. The breast milk being inadequate, various artificial foods were tried, but weight was gradually lost. There was much crying, with slow feeding, regurgitant vomiting, cyanosed extremities, mucoid and ultimately bloody stools, the child dying from hemorrhage. Autopsy showed on the posterior wall of the 1st part of the duodenum an acute ulcer,  $\frac{3}{4}$  inch long, square,  $\frac{1}{2}$  cm. distant from the pyloric sphincter. There was a second small ulcer on the anterior wall. J. A. L. Loudon (Lancet, Mar. 21, 1925).

In this connection, moreover, it is interesting to note that duodenal ulcer formerly occurred in a goodly proportion of cases of extensive burn of the body surface—according to Fenwick, in 6.2 per cent. of fatal cases of burn. These cases were doubtless the result of infection, and they have become excessively rare under the modern aseptic and antiseptic methods of dressing such wounds. Attention should be paid to the tuberculous type,—rather the latent or concealed tuberculous cases than the active, in which both gastric and duodenal ulcers frequently occur. In all cases the actual lesion is probably the result of an embolus or thrombus; and, in the light of a study made by T. R. Elliott, and subsequent investigations on similar lines, a direct toxic destruction of cellular areas cannot be ruled out. These foci, degenera-



tive from any cause, are then acted upon by the gastric juice.

The commonest type of gastric or duodenal ulcer, at least in material obtained by necropsy, is the arteriosclerotic ulcer in persons over 30 years of age (18 cases found among about 1500 necropsies). There is a second class of gastric or duodenal ulcer, in the young, probably due to local endarteritis (4 cases). Occasionally one observes acute embolic or thrombotic ulcers (1 case). W. Ophüls (*Arch. of Int. Med.*, May, 1913).

The usual ulcer of the stomach and of the duodenum in man is primarily due to a localized hematogenous infection of the mucous membrane by streptococci. Rosenow (*Jour. of Infect. Dis.*, Sept., 1916).

Most gastroduodenal ulcers have a syphilitic etiology and yield to anti-syphilitic medication. M. R. Castex (*Prensa med. argent.*, iv, 194, 1917).

In investigations on the etiology and pathogenesis of ulcer, attention is being focused on: Areas of circulatory inferiority due to developmental anomalies of the capillaries or to spasms of smooth muscle; vagosympathetic dysfunctions; local inflammations of the mucosa; bacterial agents with selective affinities for local tissues; reflex disturbances of the secretion of hydrochloric acid and pepsin; alterations of local resistance due to absence of antiferments; vasospasms of neural or endocrinal origin; functional-mechanical, thermal and chemical conditions in the gastric pathway, and trauma from food particles or violently propelled gastric contents. The multiplicity of these inquiries alone reveals the doubts that still exist concerning the etiology and evolution of the lesions. L. F. Barker (*Jour. Amer. Med. Assoc.*, Oct. 31, 1925).

**PATHOLOGY.**—In most instances the ulcer is above the site of the papilla in the duodenum. Duodenal ulcers are shelving and beveled in type, with their larger opening directed toward the mucosa, very rarely

undermined. As a rule, the wall is thick and indurated, this, of course, depending upon the duration. Adhesions to surrounding structures are very common.

Attention called to a **duodenitis** type of duodenal lesion, which is more definitely inflammatory, more congested, and more stippled than the true ulcer, but usually with little, if any, induration, so that on palpation alone it may seem as if no lesion were present. Clinically, there is little difference between this type and the true ulcer; it has been shown, however, that very severe hemorrhages may occur in duodenitis. Judd (*Jour. Lancet*, Aug. 1, 1922).

Perforation may occur before adhesions to some structure or organ have been established. In that event general peritonitis follows. After adhesions are formed, a local abscess may occur, which may rupture; or, a fistulous tract may be formed, opening into the pancreas, gall-bladder, or liver. Cicatricial contraction following an ulcer may result in retention of food, with dilatation of the stomach, obstruction of the common or pancreatic duct, or even of the portal vein.

Mayo has drawn attention to an anemic spot sometimes visible on the anterior wall of the duodenum in the common site of the scar of a duodenal ulcer. The position of this spot corresponds to the center of the area supplied by the supraduodenal artery, and in these cases it is highly probable that this vessel, arising at a high level and running down to the duodenum, is put on the stretch and has its lumen narrowed or obliterated. D. P. D. Wilkie (*Surg., Gynec. and Obstet.*, Oct., 1911).

Fifty-two chronic duodenal ulcers excised with satisfactory results without performing gastroenterostomy. Ulcers in the anterior wall of

the duodenum, with obstruction and callus, upon excision often show a defect scarcely larger than a dimple. In the larger ulcers of the anterior wall the base is not often clean-cut and grayish white, like gastric ulcer, but more resembles a moth-eaten patch. Ulcers of the posterior duodenal wall present the same characteristics as those of the stomach, that is, a clean-cut, definitely punched out area, attached closely to the pancreas and usually completely perforating the duodenum. An anterior contact ulcer is usually found opposite the lesion on the posterior wall. Excision of duodenal ulcers should be limited to those occurring on the anterior wall. Wm. J. Mayo (*Annals of Surg.*, May, 1913).

Duodenal ulcers, by the extent and character of their cicatrization, often produce crippling distortions of the bowel. Thus, there are annular constrictions; circular ulcers; hour-glass duodenum, in which there is double constriction; "kissing" ulcers, so called because they lie on opposite sides of the bowel and when the organ is empty come into contact, and diverticula, or "pouching" ulcers. The author recently met with what he terms a "tubular" constricting ulcer of the duodenum. One-half inch beyond the pyloric vein, the duodenum for about 2½ inches was constricted to about one-quarter its normal diameter. Its walls were indurated, and the condition was due to ulcer affecting the whole circumference of the bowel. A posterior gastroenterostomy was done, followed by uninterrupted recovery. Joseph Burke (*Buffalo Med. Jour.*, Feb., 1914).

**PROGNOSIS.**—Because of the greater frequency of duodenal than of gastric ulcer, and its frequent failure of recognition, at least until very recent years, the mortality has been higher than in the case of gastric ulcer. The condition is certainly an operative one in a larger proportion of cases than is the case with gastric

ulcer, and when it is recognized in time operative interference is fraught with little danger and results in complete recovery.

Two fatal cases of bleeding from duodenal ulcers in spite of the operation of gastroenterostomy. In both cases the ulcer was on the posterior surface of the first portion of the duodenum, and in both the fatal hemorrhage came on at a time when it looked as if the patients would recover from the operation. Thompson (*Annals of Surg.*, May, 1913).

**TREATMENT.**—In any case in which the symptoms have lasted for any length of time or, having been quiescent for a period, have then recurred, operative interference is absolutely essential. During the acute phases,—particularly in the cases with nervous symptoms, suffering from insomnia,—absolute **rest in bed**; careful **regulation of the bowels**; the use of **cream before meals**, about 2 to 4 ounces, with **Célestin Vichy** an hour or two after meals, and the administration of a soft **diet**—soups being, however, excluded—will frequently effect an apparent cure. If the frequency with which the long, narrow, acute-angled chest, with a prominent second rib, is to be found in these cases is borne in mind, the importance of attention to the general health will be at once apparent. (For the surgical treatment of duodenal ulcer, see Vol. I, p. 41.)

Patients with duodenal ulcer do well upon a **Lenhartz diet**. The author often combines with it ½ ounce (15 c.c.) of **olive** or **almond oil** three times a day. On this plan ½ ounce (15 c.c.) of oil is given every three hours and increased to 1 or 2 ounces (30 or 60 c.c.). Nothing else is given except water for thirst, until there is no blood in the stools. Cream is then given and the foods

of the Lenhartz diet added gradually, but not the rice. The oil is then reduced to 1 ounce (30 c.c.) before each meal. If retching or vomiting is caused the treatment should be altered. Spriggs (Brit. Med. Jour., No. 2577, p. 1916, 1910).

Dividing the cases into 4 groups, the writer states that the results of treatment are now about as follows:—

*Simple Duodenal Ulcer.*—The usual symptoms are epigastric distress 2 or 3 hours after meals; sometimes hunger pains; long periods of euphoria alternating with comparatively short periods of suffering. Gastric hemorrhage or melena may have occurred once. This group gives a comparatively good prognosis, provided that some form of **rest cure** is rigidly carried out; **rectal alimentation**, then **von Leube-Ziemssen milk diet**; or **duodenal alimentation**; or simply a **milk and egg** diet and rest abed for about 2 or 3 weeks. Later on, no overexertion (physical or mental) and a general hygienic way of living.

The oftener the attacks recur the more doubtful the prognosis by medical measures. **Operative intervention** offers a pretty good prognosis.

*Duodenal Ulcer Accompanied by Pylorospasm and Hypersecretion* (alimentary or continuous).—Severe pains and frequent vomiting. When the pylorospasm reaches a higher degree slight isochymia occurs off and on.

The prognosis of this group is not very good under ordinary methods. **Duodenal alimentation** gives a better prognosis. In case it fails after from 2 to 3 weeks, an operation should be performed.

*Duodenal Ulcer Accompanied by Pyloric or Duodenal Stenosis.*—Isochymia is here constantly present. In cases of beginning pyloric stenosis, duodenal alimentation and then stretching of the pylorus may be tried. The prognosis varies. Should there be no improvement, or in case the stenosis is further advanced, so that the duodenal bucket fails to pass, **gastroenterostomy** should be performed. Results are usually very

good. In duodenal stenosis, when situated below the papilla of Vater, there is bile constantly found in the stomach or in the vomitus. The treatment requires surgical intervention and the prognosis then becomes pretty good.

*Duodenal Ulcer with Periodically Recurring Hemorrhages.*—The chief symptom is profuse hemorrhage (either hematemesis or melena or both), which returns periodically. An interval operation gives the best results. Yet, hemorrhage may occur even after apparent recovery. Einhorn (N. Y. Med. Jour., July 21, 1917).

It is better, whenever practicable, to **excise the pylorus with the ulcerated portion of the duodenum** and anastomose the stomach and duodenum. Sir John Bland-Sutton (Lancet, Feb. 9, 1918).

Case of syphilitic duodenal ulcer in which a cure followed treatment with **arsphenamin**, **mercury**, and **potassium iodide**. The diagnosis and cure were confirmed by the X-rays. Spence (Lancet, Apr. 30, 1921).

In persons with a tendency to ulcer, the writer prescribes for 4 to 6 weeks, beginning in March and September, an **emulsion of oil with atropine** half an hour before eating. The emulsion consists of 1 egg yolk stirred into 3 teaspoonfuls of **olive oil** and then diluted with a glass of tepid boiled water. One-third of this is taken before each meal, with addition each time of 15 drops of a solution of atropine representing 0.25 mgm. ( $\frac{1}{200}$  grain) per dose. (One hour after each meal the patient takes a level teaspoonful of a mixture of 1 part each of **sodium sulphate** and **sodium phosphate** with 3 parts of **sodium bicarbonate**, in a glassful of warm water. With avoidance of excessive eating, drinking, and smoking, this procedure is capable of preventing recurrence for years. Cohnheim (Arch. f. Verdauungskr., xxvii, 241, 1921).

With the **Sippy method** the author has not had to refer more than half a dozen cases of ulcer out of over 1000 to a surgeon. The patient is given

every hour from 7 A.M. to 10 P.M. 180 c.c. (6 ounces) of lukewarm milk; ½ hour after each ingestion he takes ½ teaspoonful of a mixture of equal parts of **magnesia usta** and **sodium bicarbonate**, or in case of diarrhea, of **bismuth subnitrate** and **sodium bicarbonate**. This is kept up for several months. Only rarely is it necessary to add nightly **lavage with sodium bicarbonate solution** to make sure of the neutralization of gastric secretion. Gradually, a **soft, bland diet** is added. Baar (Northwest. Med., Mar., 1922).

Medical treatment is successful in the majority of cases. Any **focal infection** should be removed. The patient is kept quiet in **bed** for 3 or 4 weeks, next sits in a chair for increasing periods for 1 or 2 weeks, and then walks short distances. For 6 weeks he should **lie down after each feeding**. His occupation should not be resumed for at least 2 months, and the régime should be followed at least a year. The **diet** should be restricted, **small, frequent meals** being given. At first, eggs, milk and cream are best. The milk should preferably be coagulated with **rennet** or by addition of **sodium citrate**, 2 grains (0.12 Gm.) to the ounce (30 c.c.). If flatulence, diarrhea, nausea or heaviness result, **dried milk** should be substituted. If milk sourness occurs (usually due to pyloric obstruction or marked gastric atony), **gastric lavage** is in order, and the milk should be replaced by cereal with butter, potato, moist toast, soft boiled egg, shredded chicken or scraped boiled beef.

For pain, **alkalies** may be given during the digestive period or on the empty stomach, but not before meals. **Sodium bicarbonate**, 1 dram (4 Gm.) in a glass of water, may be given early in the morning, and **milk of magnesia**, ½ to 1 ounce (15 to 30 Gm.), at bedtime. If the diet fails to control the pain during the day, **sodium bicarbonate** and **light magnesium oxide** may be given. **Peppermint** may be added as carminative. **Bismuth subcarbonate** is preferable to the subnitrate. Aside from any re-

quired laxatives, **castor oil** or **calomel**, followed next morning by **milk of magnesia**, 2 ounces (60 c.c.), should be given once a week. Gastric distention is relieved or cured by **heat to the abdomen**, **sodium bicarbonate** and **peppermint**, **lavage**, **cathartics**, or **enemas** or **colon irrigations**. Under this régime most patients lose their pain and discomforts in a day or so and are symptom-free during and after the treatment. Bastedo (Med. Jour. and Rec., Apr. 16, 1924).

At first there should be a period of complete **digestive rest** and a longer period of total bodily **rest (in bed)** with protection from all disturbing psychic influences. The milder cases, however, do not require prolonged, absolute rest. The present tendency is to change to an ambulatory régime much earlier than was formerly thought permissible. Chronic ulcers are not healed in a month or 6 weeks even if a patient remains quietly in bed for that time. The abolition of symptoms is by no means synonymous with healing of the ulcer. Excess of **alkalies** may be attended by dangers of intoxication. Remedies for spasm—**belladonna**, **hyoscyamus**, **papaverine**, **phenobarbital**—may be given in small, frequently repeated doses. Cautious **intravenous injection of foreign proteins** has been vaunted of late. **Removal of focal infections** is indicated. L. F. Barker (Jour. Amer. Med. Assoc., Oct. 31, 1925).

### SIMPLE FOLLICULAR ULCERS.

These have already been considered under the chronic form of intestinal catarrh. As has been stated, the condition is usually secondary to the acute form; but it may occasionally arise without previous acute symptoms. It is the rule in portal congestion from any cause. When ulcers are present in any number, the enteritis is naturally of a more marked type, and masses of mucus occur in the stools. Pain may be absent, and

is rarely severe, the most striking features being the malnutrition, loss of weight, anemia, and mental depression. The affection is usually afebrile, and the treatment is that of chronic enteritis.

### STERCORAL ULCERS.

These are merely a form of pressure necrosis, with perhaps a certain amount of toxemia, due to the presence of hard scybala, which may sometimes be converted into enteroliths by infiltration with lime salts. Chronic constipation is the most pronounced clinical feature usually, though rarely these masses may become tunneled, so to speak, and an apparent diarrhea supervene. When the masses are low down, digital exploration will reveal them. They are most common in old age, and usually occur in the cecum, sigmoid, or rectum. There may be slight tormina, and, when the affection is seated low down, tenesmus and a moderate amount of meteorism. When the stools become loose, they contain mucus, more or less pus, and occasionally blood. In very thin people, with lax abdominal walls, fecal masses may frequently be felt.

**TREATMENT.**—The treatment should consist at first of **enemas**, without the administration of laxative medicines by mouth. From 8 to 16 ounces of warm **olive oil** should be introduced into the bowel rather slowly and with very little pressure. This should be retained for some hours, then followed by 1 or 2 drams (4 to 8 c.c.) of **turpentine** emulsified with egg albumin, 1 ounce (30 c.c.) of **glycerin**, and 2 or 3 quarts (liters) of soapy water. On the following day, a **physiological saline enema**

should be used, and if there is much pain an enema consisting of a 1 or 2 per cent. solution of **quinine and urea hydrochloride** administered. This is both anesthetic and, to a degree, antiseptic. After a thorough evacuation has been effected in this manner, the treatment should be dietetic, with particular efforts to guard against further constipation.

### ULCERATIVE COLITIS.

This condition may form part of the picture of a chronic intestinal catarrh, or may occur in the course of chronic Bright's disease, particularly toward the end, or as a result of the prolonged use of mercury. In the most marked case which I have ever seen it developed in an individual who had been giving inunctions of mercury to a tabetic over a long period, using his bare hands. On this case I conducted a post-mortem. Ulcerative colitis may also occur in scurvy, in severe purpuras, gout, and occasionally in leukemia, especially of the subacute lymphatic type. The ulcers may be disseminated or practically confluent, separated here and there by bridges of mucosa which have undergone polypoid growth. In all instances, in proportion to the duration of the condition, the wall of the bowel is thickened.

**SYMPTOMS.**—Often insidious in onset, the condition is characterized by alternating constipation and diarrhea, with pus and blood in the stools. When the disease is pronounced, emaciation becomes extreme, and irritability, marked mental depression, or even melancholia is superadded.

**DIAGNOSIS.**—The diagnostic use of a sigmoidoscope or proctoscope

should never be omitted in these cases. They often remain unrecognized until late in the course of the malady, when nutritional changes have become too pronounced to permit of recovery. Pus and occult blood or gross blood streaks in one with marked nutritional disturbance and diarrhea, or constipation alternating with diarrhea,—especially if pus be found in the stool,—should always be regarded with suspicion.

Examination of the abdomen in ulcerative colitis shows an absence of rigidity; there is tenderness in the course of the large intestine, oftenest at some one or more distinct points. The perineal mucous membranes are blanched. The grip of the sphincter is felt to be relaxed. To make more detailed examination the bowel must be cleared out thoroughly with soap and water enema, followed by irrigation at 105° F. The result in all probability will be the evacuation of a large quantity of decomposing fecal material. When the bowel has been well cleansed—and this takes from twenty-four to twenty-eight hours—an examination should be made and the sigmoidoscope then used. In the simpler forms of ulcerative colitis the mucous membrane will appear congested, blood will trickle down the open end of the sigmoidoscope, and when this has been swabbed away, eroded patches will become visible in the upper part of the rectum. In the more severe cases the mucous membrane will be found destroyed over large areas and the portions which remain appear in the form of "tags," which may become adherent one to another, forming little arches or bridges, which hang freely in the bowel. D'Arcy Power (*Medico-Surg. Jour. of the Tropics*, April, 1912).

**PROGNOSIS.**—The prognosis is always grave, and, of course, in the chronic Bright and leukemic cases

it is necessarily fatal. The same may be said of the chronic mercurial type.

**TREATMENT.**—If the case be seen sufficiently early and recognized, and the usual remedial measures prove of no avail, an **appendicostomy** should be done and the colon subsequently washed out daily through the appendiceal opening, the method which gives such excellent results in mucous colitis. Before the more severe measures are undertaken, a 2 per cent. **quinine solution**, as noted above; a 2 per cent. **creolin solution**, a **silver-nitrate solution**,—from 5 to 30 grains (0.3 to 2 Gm.) to the pint (500 c.c.),—or a 1 per cent. **protargol solution**, given by enema, may be employed. As long as coarse residue from food, such as seeds, the skin of fruits, and cellulose material, is excluded from the diet, it is advisable to administer as much food as the patient is able to take, even in the form of solid diet, in order that the nutrition may be kept up. Mastication of food is a more normal physiological act than that entailed in the drinking of liquids, and as long as the small intestine is capable of digesting the food no irritation in the colon will follow the use of a larger dietary.

In the author's most successfully treated cases of ulcerative colitis he used an **emulsion of sulphur**, 120 grains (8 Gm.) in 4 ounces (120 c.c.) of oil. This was thrown into the colon through an artificial anus every other day, and on the alternate days thorough sluicing with **boric acid solution** carried out. This was done for seven weeks. With the idea of promoting adhesion to the mucosa, Shiga has employed **enemata of gum arabic** mixed with **subgallate of bismuth**, or **iodoform**. Hawkins (*Brit. Med. Jour.*, May 27, 1909).

Instillations of warm olive oil or liquid petrolatum with bismuth or orthoform and 1 or 2 per cent. argyrol solution found very useful; likewise, an aqueous extract of *krameria*. As irrigating media the author uses either plain water, saline solution, or solutions of boric acid, sodium bicarbonate, hydrogen peroxide (2 per cent.), potassium permanganate, chloramine-T, or silver nitrate. In 10 cases he used autogenous vaccines, consisting of *B. coli* in 5 and *B. coli* plus *Staphylococcus albus* in the remainder; 3 cases were apparently cured and 3 much improved. In 3 cases blood transfusion was done, with permanent improvement in 2. F. C. Yeomans (Jour. Amer. Med. Assoc., Dec. 24, 1921).

**Bismuth salicylate** by mouth found of definite value. Early resort should, however, be made to irrigations in some form. Surprising results have at times been obtained in aggravated cases with chlorine preparations. Where, in the very bad cases, nothing will do but putting the entire colon at rest, this is best done by a double-barreled ileostomy 6 to 8 inches above the ileocecal valve, the proximal opening serving as a fecal exit and the distal for irrigations. When the pathologic condition has disappeared, the writer often prefers to do an ileosigmoidostomy and retain the distal opening for occasional irrigation, rather than to restore complete continuity and open the door to relapse. R. W. Jackson (Jour. Amer. Med. Assoc., Dec. 24, 1921).

In severe, obstinate cases, certain dyes are of great benefit. The Gram-positive and Gram-negative organisms in the stools are counted as one would leukocytes. One-third Gram-positive and  $\frac{2}{3}$  Gram-negative are taken as the normal standard, and departures either way serve for the dye selection. The coli-dysentery-typhoid organisms are all Gram-negative and are best controlled with neutral acriflavin, while the streptococci, staphylococci, *B. anthracis*, *B. putrificus* and *B. Welchii* are Gram-positive and are inhibited by

gentian violet. Acriflavin is used in 1:1000 to 1:5000 strength and in amounts up to 1 liter. It may also be used by duodenal tube, preferably in normal saline solution, or by enema, and in 0.1 Gm. ( $1\frac{1}{2}$  grain) enteric-coated tablets taken frequently during the day it is of benefit at the conclusion of active treatment. Gentian violet is used in 1:1000 to 1:8000 solutions; by duodenal tube, best in hypertonic solutions, or by enemas or enteric 0.5 Gm. ( $7\frac{1}{2}$  grain) pills. A. Bassler (N. Y. Med. Jour., July 18, 1923).

**Pancreatic preparations** are of value in obstinate cases. Other measures advocated are rest in bed, the thermophore over the abdomen, and ingestion of calcium, tannin and bismuth preparations. L. von Friedrich (Deut. med. Woch., Aug. 15, 1924).

In chronic ulcerative colitis in childhood, of which the writer has seen 11 cases, the treatment should consist of the location and removal of possible foci of infection, the use of a specific vaccine, and improvement of resistance by blood transfusion. Helmholz (N. Y. State Jour. of Med., Jan. 15, 1926).

### DUODENAL DIVERTICULUM.

—This lesion may be either congenital or acquired. According to Judd, it is usually acquired, being produced by the contracting scar of duodenal ulcer. True diverticulum is rare, but pouchings and sacculations, with or without associated ulcer, are comparatively common. The true diverticula are for the most part congenital malformations. They occur generally in the descending and inferior portions of the duodenum. The walls of the acquired diverticula consist merely of mucosa, and protrude through the musculature either along a vessel or through the opening for the passage of the common duct (Holzweissig).

Duodenal diverticulum may not

cause any symptoms. Where symptoms exist, the most constant is pain, ranging from a dull ache to a sharp, colic-like pain suggesting gall-stones. It is usually referred to the epigastrium and right scapula, but the point of maximal tenderness is generally above the umbilicus to the right of the midline. The pain is *not* relieved by taking food. A definite diagnosis is made by X-ray examination.

Some duodenal diverticula are transient and are relieved by medical measures (Andrews). A minority present pouches calling for surgical treatment—usually the freeing of adhesions and removal of the diverticulum, sometimes with an added gastroenterostomy.

### INTESTINAL TUBERCULOSIS.

**ETIOLOGY.**—Intestinal tuberculosis is said to occur both as a primary and as a secondary manifestation, though as a primary condition it is extremely rare. Further doubt is thrown upon its primary existence when one calls to mind the experimental work of G. S. Woodhead, who fed infected, tuberculous food to animals. The organism was found to pass through the intestinal wall, involve the peribronchial lymph-glands and lungs, in by far the greater proportion of instances without leaving evidence of intestinal involvement, and only in the minority did there result an involvement of the mesenteric lymph apparatus. Northrup also called attention to this fact, from the clinical and post-mortem standpoints, in the case of bottle-fed children. Occasionally, one meets with a case in an adult in which the symptoms are primarily those of appendicitis, but which subsequently

develops intestinal tuberculosis, or, rarely, the peritoneum may be primarily infected. Intestinal tuberculosis occurs by far most commonly in children, especially in the bottle-fed.

**PATHOLOGY.**—Intestinal tuberculosis is associated, as a rule, with more or less enlargement and caseation of the mesenteric lymph-glands, occasionally also with peritonitis. The mesenteric cases in children were at one time described as *tabes mesenterica*. Secondary intestinal tuberculosis is very common, and is associated with pulmonary tuberculosis, the bowel lesions in most instances being in the lower end of the ileum, the cecum, and the first portion of the ascending colon. Not rarely isolated ulcers may occur in the rectum, and, indeed, this latter may constitute the only site of tuberculosis in the intestines, and give rise to fistula in ano.

The morbid change begins in the intestinal lymph apparatus or occasionally within the mucosa. Tubercles form, which become confluent, caseate, necrose, and form ulcers. Unlike typhoid ulcers, tuberculous ulcers present their long diameter at right angles to the long axis of the bowel. They are irregular, sinuous in outline, with infiltrated edges and base, and upon the serous surface, especially near the attachment of the mesentery, and sometimes leading into the mesentery, minute tubercles may occasionally be seen. Frequently the submucosa and muscular layers are involved. There is very little, if any, tendency to healing. Perforation and peritonitis may occur, though less frequently than in the case of typhoid fever. Occasionally, fatal hemorrhage occurs. In



very chronic cases cicatrization may be more or less complete, even resulting in the formation of strictures. In the chronic type the peritoneum over the ulcers is not seldom thickened.

The rarer form of chronic tuberculosis of the intestine is that in which the ileocecal region is involved. This form is characterized by marked hyperplasia and thickening, often involving the appendix in plastic exudation, without much caseation, and often without ulceration. These changes are apt to result in the formation of a firm, tumor-like mass, which may be mistaken for a malignant growth. The parts are firmly bound by adhesions, and are more or less tender on pressure. Rarely in women tuberculosis of the tubes, and in children tuberculosis of the mesenteric glands, may result both in peritoneal and intestinal tuberculosis.

**SYMPTOMS.**—Irregular fever and emaciation, with gastrointestinal disturbance, anorexia, and in some instances night-sweats, constitute the symptomatic picture of intestinal tuberculosis. In some instances the diarrhea is the most troublesome feature, and in these, very frequently, amyloid disease has resulted from the underlying tuberculous process.

In the hyperplastic, ileocecal form of intestinal tuberculosis the predominating symptoms simulate those of chronic recurrent appendicitis or chronic intestinal obstruction, consisting of more or less severe pain and, from time to time, diarrhea alternating with constipation.

Tuberculous mesenteric glands are to be found in practically every child submitted to operation. There can be no mistake in assuming that the great mode of entrance of tuberculosis from the intestine to the

body is by the lymphatics of the ileocecal region, and that, therefore, tuberculosis of the mesenteric glands originates from there. The children suffer from chronic ill health, and from abdominal pains referred to the umbilical region coming on at night and sometimes after food. With anorexia there is often disturbed bowel action, generally constipation. There is always found in these cases a somewhat dilated appendix, containing fecal material, but otherwise not diseased. The author accordingly **removes the appendix** in these patients. Two or three weeks after operation the patient is sent away to a country home. In 9 cases out of 10 improvement is rapid and marked. Corner (Lancet, Feb. 17, 1912).

Case of primary mesenteric tuberculosis with the clinical picture of acute ileus in a boy of 16. In a second case the onset was equally sudden, and acute appendicitis seemed unmistakable. Both patients were apparently cured by prompt **excision** of the nodes involved. Schloessmann (Beiträge z. klin. Chir., April, 1912).

*Cecal tuberculosis* classified in 3 types, the ordinary ulcerative, the hypertrophic and a mixed variety. Local swelling, fixed or movable, can frequently be detected. The symptoms themselves are not distinctive, leading to confusion with many other abdominal conditions. Mixed infection aggravates and accelerates the symptoms, and may induce all manifestations of the "acute abdomen." Strictures may result from fibrous healing of a large tuberculous ulcer or from hypertrophic narrowing of the lumen. The diagnosis of cecal tuberculosis is made by the finding of tubercle bacilli in the feces, coupled with evidences of disturbance in the right iliac fossa. W. D. Read (Northwest Med., Oct., 1921).

**DIAGNOSIS.**—The relatively prolonged course and the nutritional disturbance are the chief clinical evidences of tuberculosis of the intestines. When, in any case, the lungs

become involved the diagnosis is, of course, clear.

As stated by Nash, blood in the feces rarely occurs in tuberculosis of the cecum. The lymphatics of the mesentery become enlarged much more rapidly and more extensively than in carcinoma. In the diagnosis of tuberculous intestinal tumor, according to Hemmeter, the possibility of cecal cancer, dislocated kidney, fibrinous appendicitis, and scybalous accumulations must be considered. The age, slower progress, presence of pulmonary disease, tubercle bacilli in the stools, and diazo reaction are among the principal points of difference from carcinoma. The distinction from fibrinous appendicitis can often not be made except by observation of the course of the disease.

In 475 autopsies of chronic pulmonary tuberculous cases there were 13 instances, or 2.7 per cent., of intestinal perforation. Ten were complete and 3 partial. The small gut was perforated in 6, and the large in 4. Acute peritonitis was present in 4 cases. Of the perforations in the large gut, 3 were in the appendix and 1 in the head of the cecum. There can be advanced disease of the peritoneum in chronic tuberculosis without any marked symptoms or clinical signs. Only 4 cases of complete perforation had fairly typical symptoms and signs of perforation. J. M. Cruice (Amer. Jour. Med. Sci., Nov., 1911).

In 39 of 45 cases of tuberculous ulceration of the intestines, pulmonary symptoms preceded the intestinal. In every case general symptoms, such as loss of energy or weight or increase of nervous irritability, appeared before the local symptoms. Nervousness was prominent in 5 cases and fairly marked in 19; 32 complained of anorexia, which was the first symptom in 15; discomfort was complained of in 33, and was the first local symptom in 7. Definite pain was present in 42, but was the first symptom in only 5; in advanced disease it was rarely absent. Flatulence was present in 26, nausea in 19, vomiting in 10, and constipation in 19. Diarrhea oc-

curred in 40 cases. In only one case was there even slight rigidity, and in only 2 cases were masses palpable. Tenderness was noted in 22 cases, most frequently in the right iliac fossa. Barium meals were given to 44 patients, and in 43 definite filling defects were found. Hypermotility was demonstrated in 8 cases. The stools were examined in 42 cases after a meat-free diet for 3 days, and tubercle bacilli were found in 20. Occult blood was found in 30 of 42 specimens of feces. J. E. Pritchard (Can. Med. Assoc. Jour., Jan., 1924).

Unless tubercle bacilli are present in the stool in fair number, they are not diagnostic, as it is readily conceivable that with the ubiquitousness of the germ they may be swallowed from time to time. When they are found, however; with a greater or less number of pus cells and blood, and especially if they occur in association with a pulmonary lesion and are found in the sputum, the diagnosis is confirmed.

The prognosis is always grave, though rarely cicatrization may occur.

**TREATMENT.**—In the localized form, situated about the appendix, cecum, and ileum, operative interference may be practised with a fair measure of success.

Use of dilute hydrochloric acid in tuberculosis recommended to prevent the infection of the intestines. J. C. Hemmeter (Jour. Amer. Med. Assoc., Feb. 29, 1908).

Two cases of extensive excision of the colon and ileum for tuberculous disease. The cecum, 4 inches of the colon, and 27 inches of the ileum were taken away in 1 case. The patient was well three years later. The second case, involving the cecum, descending colon, and hepatic flexure, was treated by a lateral anastomosis of the ileum to middle of transverse colon. Later on resection of the diseased parts was practised. This

case also recovered. Barker (*Lancet*, Sept. 23, 1911).

**Surgical treatment** is suitable in some cases but of limited applicability. The most promising treatment is the **ultraviolet ray**, given by the **quartz lamp**, using, perhaps, the X-ray as well. D. A. Stewart (*Can. Med. Assoc. Jour.*, Jan., 1923).

**Calcium chloride** tried as adjuvant to **heliotherapy** and **dietetics** in 70 cases of intestinal tuberculosis, with good results. Five c.c. (1¼ drams) of a 5 per cent. aqueous solution of recrystallized calcium chloride were injected intravenously once weekly, every fifth day, or weekly, as required by the effects observed. E. H. Roberts (*Amer. Rev. of Tuberc.*, Apr., 1924).

**Pneumoperitoneum treatment** recommended. The author's case had 3 to 5 loose movements daily, with considerable abdominal pain. For the first injection, about 300 c.c. of **oxygen** were used, and for the second 1500 c.c., the injection being made on the left side of the abdomen at a point corresponding to McBurney's. The temperature fell back, pain and diarrhea diminished, and he was able to take food. After the 2d injection his intestinal condition was nearly normal, and a year later he was still living comfortably. R. L. Laney (*Amer. Rev. of Tub.*, July, 1924).

### INTESTINAL SAND.

This may be false or true sand. The former type consists especially of food residue, *e.g.*, seeds, fishbones, grain husks, and portions of the cores of pears or apples. Bananas are also said to give rise to this condition.

When, for any reason, phenyl salicylate (salol) is not properly broken up into its components in the first part of the intestine, it may pass through in the form of a sand. Olive oil occasionally forms little masses somewhat resembling gall-stones.

True intestinal sand, which occurs

more frequently in women than in men, consists of a gritty material, largely composed of carbonate and phosphate of lime. These particles are of no clinical importance unless present in notable amount, when they act as mechanical irritants, producing colicky pain and mucous colic.

The passage of intestinal sand or calculi may be attended by severe colic, which cannot, however, be explained by the narrowness of the canal. Distention is frequent, with or without eructations. The attack lasts several hours or a day.

In the treatment, in addition to relieving the pain by **opium** and **belladonna**, the stagnation and accumulation of sand and calculi should be overcome by **colonic irrigation**. The prophylactic treatment consists of a proper **diet** and **avoidance of constipation**. **Laxative waters** are indicated. Louis Vibert (*Revue de therap.*, June 15, 1901).

False intestinal sand is composed of remains of vegetable foods, perhaps a little incrustated with earthy salts. Pears, which often contain this sand before being eaten, are probably the most abundant source. True intestinal sand originates within the bowel. It occurs almost always with intestinal disorders. The characters of the organic bases and the large numbers of bacteria included point to the intestine as the most likely seat of origin. The richness of the material in urobilin and its poverty in unaltered bile pigment suggest that it is formed in a region where conversion of bile pigment is far advanced, namely, in the upper colon. It is not necessary to look to unabsorbed residues of the lime in food as the sole source of supply. Bunge has shown, however, that the actual amount of lime in milk is greater than in an equal volume of lime-water, so that this food may perfectly well be the source of lime in concretions. D. Duckworth and A. E. Garrod (*Lancet*, March 8, 1902).

**Case of true intestinal sand.** The chemical analysis showed: Moisture, 5.2 per cent.; calcium phosphate, 28.68 per cent.; calcium carbonate, 5.2 per cent.; magnesium phosphate, 0.49 per cent.; organic matter, 60.43 per cent. At the time the sand was passed the patient, a lady aged 44 years, had been on a milk and farinaceous diet for months on account of gouty diathesis. The gouty diathesis might bear an etiological relation to the production of the sand. Bedford (Brit. Med. Jour., Dec. 6, 1902).

A man suddenly developed symptoms of ileus, and after extensive bowel irrigation passed 50 cherry-stones. Ten or eleven months had passed since he had eaten the cherries. Case of a young physician who had used for ten years a mouth-wash of tincture of myrrh and krameria to relieve painful gingivitis. Particles of resin in the mouth wash collected in the digestive tract and caused symptoms suggesting recurring appendicitis, when, in fact, the trouble was merely irritation of the mucosa from the rubbing of the conglomerations of resin. These accumulated at the sigmoid flexure and sometimes caused slight fever, but the symptoms were always comparatively mild. The disturbances were cured by **dieting to insure soft stools** with as little development of gas as possible. The case had been puzzling until the discovery of resin lumps in the stools. B. Naunyn (Deut. Archiv f. klin. Med., Bd. lxxxiv, Nu. 1-4, 1905).

### INTESTINAL CALCULI.

These are rare, occasionally of biliary or, still more rarely, of pancreatic origin. True enteroliths may result from the impregnation of fecal matter with lime salts.

### INTESTINAL OBSTRUCTION.

**DEFINITION.**—Any part of the intestines may be obstructed completely or only in part, and the proc-

ess may be acute, subacute, or chronic. The term *ileus* is sometimes rather loosely employed to cover all of these forms, especially that condition commonly termed paralytic ileus, which is essentially intestinal paresis following abdominal operations. The word literally means, to roll, and it should be applied solely to inflammatory or spasmodic volvulus. The following terms are variously employed, according to the condition present: *Occlusion*, signifying complete obstruction of the lumen of the bowel; *stenosis*, considerable narrowing of the lumen or incomplete occlusion, so to speak, from any cause; *constriction*, narrowing due to extramural compression or traction; *stricture*, narrowing due to a cicatricial ulcer, gumma, or malignant growth; *obturation*, the presence of some intramural obstruction, i.e., some factor operative within the lumen, as a foreign body, gall-stone, enterolith, or impacted fecal matter; *strangulation*, signifying not alone occlusion, but interference with blood and nerve supply, leading to gangrene; *incarceration*, which should not be confused with strangulation, and implies the imprisonment of more or less extensive coils of the intestine in pouches or cavities, usually scrotal or retro-peritoneal. One interesting form of incomplete obstruction, i.e., constriction, is Littre's hernia, in which only part of the lumen of the bowel or a diverticulum is caught in a fold or pouch.

### SYMPTOMS.—Acute Obstruction.

—This may result from strangulation, intussusception, volvulus, peritonitis, and foreign bodies, or it may be postoperative. It is rapid or sudden in onset, constipation, abdominal pain, and vomiting, with or without nausea, constituting the chief phe-

nomena. There is gradual development of gaseous distention only when the obstruction is low down, and occasionally a palpable mass. Pain is frequently the first symptom, often coming on suddenly; it is at first intermittent, colicky, and later more or less continuous and severe. When the lesion is low down, peristalsis may be visible above the obstruction. Nausea and vomiting soon follow, and hiccough is not uncommon. First, food contents are vomited, then a thin mucus, and later bile-stained material, while in occlusion the vomiting becomes distinctly stercoraceous. Early, an apparent movement of the bowels may occur as a result of peristalsis below the site of obstruction, but absolute constipation is the rule, neither gas nor fecal material escaping, though tenesmus may cause the passing of some mucus.

Study of 55 cases of acute intestinal obstruction, with 19 deaths, and 10 cases of obstruction due to carcinoma of the bowel, with 4 deaths. The records of the fatal cases showed that all these patients had been ill for several days, hence the delay in diagnosis and postponement of operation were to blame. Practically all had been purged, thus accounting for perforations, gangrene and peritonitis. Most of them had been given opiates, which masked the symptoms, gave false security and delayed surgical intervention. The physical condition of every patient was critical when he finally came to operation. C. W. Flynn (Tex. State Jour. of Med., Sept., 1924).

Obstruction high up causes very little tympany. Obstruction of the large bowel may result in considerable distention. As a rule, more or less tenderness on pressure exists, sometimes exquisite, so that it is often impossible to feel a mass even

when present. Rectal or vaginal examination may furnish some information.

Among the symptoms of intussusception of the sigmoid, as described by Lynch, are: A feeling of unfinished stool, following a movement of the bowels; aching pain in the sacrum; a passage of mucus or membrane; a dragging sensation in the left iliac region, with a feeling of heat across the lower portion of the abdomen and back; periodical attacks of hemorrhage from the bowels; colicky pains before the bowels move; pain on sitting or standing for any length of time; headache, vertigo, nausea, vomiting, frequent and painful urination, and pain down the back of the legs. The symptoms vary with the degree of intussusception, the length of time it has existed, and the involvement of other organs. The operative treatment advised consists essentially in suspending the intestine by passing 3 or 4 Pagenstecher sutures through the inverted transversalis fascia.

Symptomatology of acute intussusception in infants described as follows:

There is severe and sudden abdominal pain, coming on in acute attacks with intervals often of complete relief. The child may vomit, but never to any great extent. Tenesmus is marked, but with passage only of a little blood and slime. At first a motion or two may be passed, but after this there is absolute obstruction, and no trace of bile will be found on the napkin. This sign, first pointed out by Barnard, is almost infallible.

The abdomen is fairly lax in these cases, unless the child is actively straining. A tumor may be felt in the region of the transverse or descending colon. It gradually shifts its position, advancing along the colon and increasing in extent. It is sausage-shaped and of horseshoe form, the concavity being toward the center of the abdomen. Manipulation causes it to contract and become hard, producing an attack of pain and an increase in the tenesmus. The characteristic feature is that,

although the tumor may not be very tender, and manipulation may cause no instant pain, the pain rapidly follows and continues long after manipulation has ceased. The apex may be felt by the rectum. H. S. Souttar (Brit. Med. Jour., May 10, 1913).

The patient soon shows evidences of profound illness. Anxious expression, pallor, cold sweat, sunken eyes, rapid heart, feeble pulse,—in short, collapse. The temperature is often subnormal, though it may be raised when peritonitis occurs,—not always, however. There is marked dryness of the mouth with constant thirst. When the lesion is high up, the urine is greatly diminished or even totally suppressed, while in lesions low down the urine is more or less scanty, dark, and apt to contain a quantity of indican. A leucocytosis, often of from 50 to 80 thousand, is not uncommon. Death usually occurs within a week, unless operative interference is practised.

**Chronic Obstruction.**—This condition, following the development of new growths, strictures, or fecal impaction, may extend over considerable periods of time, though, finally, urgent symptoms may suddenly develop, the case becoming acute. As a general rule, however, the chronic type varies somewhat, according to the underlying cause. In fecal impaction there is usually a history of chronic constipation, and, as has previously been noted, this may be masked as a result of tunneling of the intestinal contents, an apparent diarrhea resulting. This is especially the case in old people. More or less abdominal pain and distention, sometimes the passage of mucus, together with the history, and, in thin individuals, palpable masses in the abdomen,

constitute the clinical picture. Colitis, stercoral ulcers, even hemorrhage or perforation, may result.

In stricture, whether benign or malignant, the history is one of moderately long standing and gradually increasing constipation. Peristalsis is apt to be very active above the site of the obstruction. Pain is usually less severe, often absent; meteorism intermittent, unless the obstruction becomes complete, and vomiting is only occasional and may not occur at all, and is never fecal, except in late, complete obstruction. The general health suffers, doubtless in part owing to autointoxication, with anemia and loss of flesh, and death occurs from asthenia or acute obstruction. The stethoscope is not employed sufficiently in the diagnosis of abdominal conditions, as in peritonitis, or even in appendicitis with local peritonitis, in postoperative distention, and frequently in all forms of obstruction no intestinal sounds can be heard.

**DIAGNOSIS.**—In this connection there are to be considered both the site and nature of the obstruction and its recognition from other conditions which may simulate it. As to the site of obstruction, it is not always possible to determine this absolutely,—indeed, rather more frequently it is impossible,—but the age of the patient, and to a less extent the sex, are factors of considerable aid. For instance, volvulus, malignancy, and chronic constipation are to be looked for in the aged; intussusception, a constricting appendix, or Meckel's diverticulum in a child, and either of the latter two in youth or early manhood. The history is of importance as to whether operation has previously

been undergone, or an attack of peritonitis experienced, or whether previous ulceration of the bowel has probably existed as the result of some old infection. Digital rectal examination and inspection of the abdomen, and in women even a vaginal examination, may furnish collateral evidence. Either in the nature of a mass; or in the case of an obstruction high up, in the feeling of the empty coils of intestine which fall into the pelvis. Inspection of the abdomen is of value in noting the distribution of peristalsis and of tympany; the higher the obstruction, the less the tympany, and the converse is likewise true. Again, in obstruction high up, diminution of the urine or anuria, and the absence of indicanuria, are in striking contrast with the large amount of indican occurring in a more or less scanty urine when the obstruction is low down.

Even before any other signs indicate obstruction of the bowels, the stomach tube will aspirate fecally smelling stomach content. The author washes out the stomach on the slightest suspicion of ileus, and comments on the promptness with which the stomach fills up again with fecal matter after it has been evacuated. The violence of the general symptoms abates after the stomach has been thus emptied, and the patient comes to operation in much better condition. Ewald (*Berl. klin. Woch.*, Nov. 4, 1907).

Persistent abdominal pain of severe type, with abrupt onset, in a patient in previous good health, unrelieved by rest and starvation, is the most notable sign and often the only one upon which a diagnosis of acute obstruction may be founded. In a majority of cases the fate of the affected gut is determined, and immediate operation demanded, within twenty-four or forty-eight hours.

One should, therefore, not wait long for the development of a complete clinical picture. E. W. Hey Groves (*Bristol Med.-Chir. Jour.*, March, 1912).

It is well to remember that not all the symptoms of intestinal obstruction may be present. This is practically true of vomiting, and especially of the type which is usually considered pathognomonic, viz., stercoraceous vomiting. It is a serious mistake, in the presence of other strongly suggestive symptoms of obstruction, to wait for vomiting, or the distinctive stercoraceous vomiting, to confirm the diagnosis. The "mapped-out" variety of distention in many cases does not exist; especially in late cases, it may be entirely masked by general distention. F. D. Gray (*Med. Times*, Sept., 1912).

When the ileum and cecum are obstructed, distention is noted, especially in the central portion of the abdomen. Early fecal vomiting is then the rule. When the colon is involved, tenesmus frequently occurs, with passage of mucus and blood, and this is especially noteworthy too in intussusception, which occurs more frequently in children than adults. The course of the condition is somewhat slower when the colon is obstructed than when the small bowel is involved. Very little help may be expected from inflation with gas, and, as a rule, not a great deal from an attempt to determine the amount of fluid which the colon will hold. In volvulus this might be of some value. Better still, however, would be the introduction of a bismuth mixture by rectum, followed by an X-ray examination. Auscultation during inflation may occasionally aid in locating the site. In adults the capacity of the large bowel is from 5 to 6 quarts, but great care should be ex-

exercised not to use too much pressure, lest an already damaged bowel be ruptured.

Tympany is rare in the early stages, and is really a late symptom in acute obstruction. The vomiting at first is due to pylorospasm. The almost constant symptoms are vomiting, constipation, and pain, the latter cramp-like, with severer paroxysms associated with reflex vomiting. The diagnosis is best made on the finding of: (1) Peristaltic pain increased by food or cathartics; (2) persistent vomiting not lessened by lavage; (3) constipation not relieved by enema (though at first enemata may bring a slight fecal return). Marked leucocytosis occurs only in later stages, as does also an increase in blood urea. In early cases, if mere fecal impaction rather than obstruction seems a possibility, the writer gives an enema of 4 ounces (120 c.c.) each of castor oil and olive oil, or even a moderate dose of castor oil by mouth followed by a soapsuds enema and possibly a hypodermic of pituitary extract. If no evacuation occurs and symptoms are aggravated the diagnosis of obstruction should be considered as fairly well established. Andresen (N. Y. Med. Jour., June 7, 1922).

Utility of X-ray examination in uncertain cases emphasized. Administration of opaque suspensions need not be attempted, the shadows alone proving sufficiently informative, sometimes revealing other causes for the symptoms and making unnecessary a proposed exploratory operation. Guillaume (Presse méd., Jan. 4, 1922).

Among the most difficult obstructions to recognize are those in the nature of constrictions or strangulations resulting from Littré's hernia; likewise, constrictions in the foramen of Winslow or retroperitoneal hernias.

The nature of the obstruction oftentimes escapes recognition. Since the majority of cases of occlusion

are due to strangulation, especially in males, age and sex in this connection may again furnish collateral evidence. Tumefaction is very rare in this type. An examination of all possible sites for the development of hernia should be made and the history as to mode of onset, presence or absence of anemia, emaciation or cachexia, previous gall-stone colic, or constipation obtained. In children tumefaction, tenesmus, and bloody, mucous stools favor intussusception, and in old age the greater possibility of volvulus may aid in detecting the nature of the trouble. Fecal obstruction is, as a rule, among the easiest of conditions to recognize.

As to differential diagnosis, the following conditions may be considered: Acute appendicitis or pancreatitis, peritonitis, and rarely a very acute enteritis with relaxation of the intestinal walls, abdominal pain, and vomiting. The presence or absence of fever, however, should determine the probability of disease of the appendix, and usually of the peritoneum, with local or general pain on pressure. In acute hemorrhagic pancreatitis it may be possible to elicit a history of typhoid fever, of previous gall-stone colic, or of marked gastric hyperacidity with acid eructations, pronounced irritability, and epigastric pain. Embolism of the mesenteric arteries, or thrombosis of the mesenteric veins, may also simulate obstruction from other causes. Gall-stone or renal colic, or torsion of the pedicle of a tumor or of a movable kidney of the third degree, may likewise interpose difficulties.

Time lost in waiting for a sausage-shaped tumor to be palpable or for intussuscepted gut to appear in the



rectum in an infant may be sufficient to cost the life of the little patient. With the small gut distended palpation of the cecum may be impossible, or there may be an intussusception so small that no mass is palpable, or the whole mass may be hidden behind the ribs in the splenic flexure of the colon. In the case seen early, when treatment is most efficacious, the mass in the rectum is rarely met with. With a history of sudden onset of screaming, intractable vomiting, evidence of continuous pain, and blood and mucus in the stool, with an absence of fecal matter in the stool, a diagnosis of intussusception, particularly in infants under a year, may be safely made. There need be no great prostration at first, and this is the ideal time for operation. The X-rays are available for diagnosis in the doubtful cases, and should not be neglected. L. Miller Kahn (*Med. Rec.*, Sept. 20, 1913).

In any case it may be deemed advisable to administer a general anesthetic, or, better, spinal anesthetic, which may greatly facilitate diagnosis. The use of spinal anesthesia in the postoperative cases, with paresis of the wall of the bowel, not only aids in the diagnosis, but at once puts a stop to the condition.

**ETIOLOGY.**—Intestinal obstruction may be due to (a) extramural; (b) mural, or (c) intramural factors.

**Strangulation.**—This is the most common of the extramural causes of acute obstruction. It may be due to adhesions, postoperative or acquired through previous peritonitis or preceding inflammation of an organ, with subsequent formations of adhesions; mesenteric and omental slits; pedicles of tumors; remnants of fetal structures, such as Meckel's diverticulum or fibrous remnants of fetal vessels (vitelline); an adherent appendix, which may form a loop or may sur-

round the ileum or cecum, usually the former; openings or pouches in the peritoneum, or inflammatory traction upon an intestinal loop, causing kinking; internal hernias through the foramen of Winslow; duodenojejunal, subcecal, intrasigmoid, diaphragmatic or Littre's hernia, or external pressure due to abscess formation, especially about the appendix or within the pelvis; cyst of the pancreas; hydronephrosis; abdominal or pelvic tumors, as of the ovary, uterus, kidney, or omentum. Kinks due to traction usually occur in the last part of the ileum, at the sigmoid, or the last part of the duodenum.

In cases of ptosis this latter is apt to occur, when it is spoken of as gastromesenteric ileus, the last portion of the duodenum being compressed by the root of the mesentery and its vessels. Acute dilatation of the stomach may arise in consequence. The kink of the ileum not infrequently associated with the mobile cecum, the condition to which the term Lane's kink has been applied, usually develops in the proximity of the cecum, where the mesentery is short. The mobile cecum falling over the brim of the pelvis may result in more or less definite obstructive symptoms, or may give rise to symptoms suggestive of an acute appendicitis.

According to Fitz, obstruction due to strangulation occurs in males in 70 per cent. of all cases, and in 40 per cent. of all cases between the fifteenth and thirtieth years. In 90 per cent. the small intestine is involved, considerably over two-thirds of these occurring in the right iliac fossa and four-fifths in the lower abdominal half.

**Intussusception.**—Of the mural forms, intussusception is most common in children, more than one-half of the cases occurring before the tenth year, and many even before the termination of the first year of life. It is a very common cause of acute obstruction, much more frequent in males than females.

According to Elliot and Corscaden trauma is a frequent factor in causing intussusception in adults, *e.g.*, certain acrobatic feats, the lifting of heavy weights, wrestling and football.

The symptoms of intussusception, which is prevalent in infants of 3 to 9 months, are these: Sudden, acute, colicky paroxysms, lasting 1 to 3 minutes and alternating with a 5 to 10-minute rest period; nausea and vomiting; tumor, generally palpable before meteorism develops; severe prostration; tenesmus, especially when near the rectum; bloody stools; lack of temperature. X-ray examination completes the diagnosis, which must exclude volvulus and cholera infantum. T. E. Craig (Ky. Med. Jour., Nov., 1922).

Intussusception due to a cecal mucous cyst in an 8 months' infant. A mass was felt in the left side; digital rectal examination revealed an indelinite fullness in the upper pelvis. At operation an ileocecal intussusception was unfolded, but the hard mass within the cecum necessitated resection. A. T. Bazin (Can. Med. Assoc. Jour., Feb., 1925).

In this condition infolding of the bowel occurs, the invagination being always a descending process (*post mortem* the reverse is often found, non-inflammatory, agonal). The upper portion of the bowel is swallowed by the lower, as it were, in consequence of which a tumor of cylindrical shape results, from a fraction of an inch to one or more feet long.

An intussusception is formed of

three layers: the intussusciens, or outer receiving layer, which, folding back upon itself, constitutes a middle or returning layer, and this, again, turning upon itself, forms the innermost or entering layer, or intussusceptum. A preceding diarrhea, a polypus or lipoma, or other benign pedunculated growths are the usual factors inviting this condition.

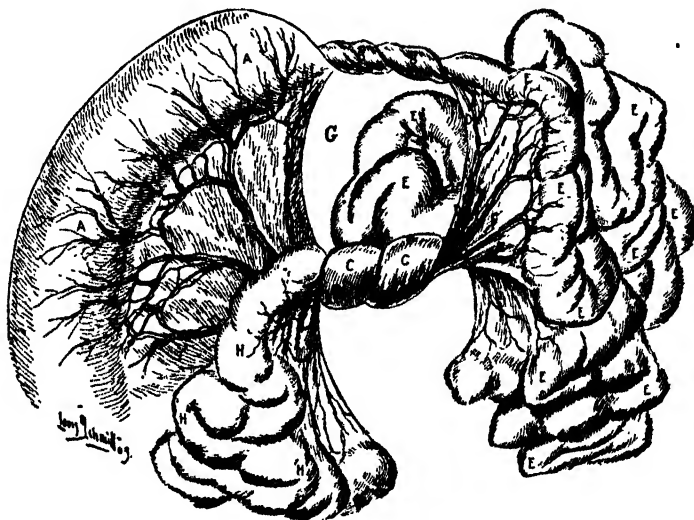
According to Fitz, intussusception constitutes 31 per cent. of the acute cases of obstruction. Several varieties exist, which from above downward are styled the *ileal*, in which the ileum alone is involved; the *ileocecal*, in which the ileocecal valve descends into the colon and may be so extensive as to be felt per rectum (this last comprises about three-fourths of all cases); the *ileocolic*, in which the terminal portion of the ileum passes through the ileocecal valve, into the cecum or beyond into the ascending colon; rarely an *appendiceal* form, in which the vermiform appendix enters the cecum; the *colic*, confined solely to the colon, and finally the *colicorectal* form, in which case the colon descends into the rectum.

In consequence of the invagination, the mesenteric vessels are compressed, especially those distributed to the middle and outer layers, so that oozing of blood or even considerable hemorrhage, with mucous stools, constitute an important clinical feature. The invaginated portion may slough, and in rare instances, when the middle and outer layers have previously become adherent, spontaneous cure has resulted, and occasionally the slough is discharged per rectum, as in a case of typhoid which came under my notice in which about 2 inches of bowel were passed by

rectum, with subsequent cure of the patient, without operative interference. It is rather surprising that intussusception does not occur more frequently in typhoid, because active irregular peristalsis is the essential predisposing factor.

The involved area is always more or less thickened and swollen, and later becomes pultaceous and gangrenous. Early, it may be readily re-

against the handle of a washtub. She suffered from no great shock and was able to continue her work on the following day. About a month later she developed symptoms of indigestion, which became progressively worse until, ultimately, the taking of food was followed immediately by pain and frequent vomiting. In 1906 the vomitus presented a coffee-ground appearance on several occasions. At varying periods the patient vomited food



*A*, dilated loop of jejunum; *B*, twists in jejunum, causing obstruction; *C*, twists in upper ileum; *D*, edges of mesenteric rent; *E*, eight-foot length of small intestine, which, rotating about its own mesentery *F*, has passed through the mesenteric rent *G* three times; *H*, ileum distal to the lesion.

duced, but when adhesions have formed it becomes fixed, and about the involved area more or less lymph is thrown out.

**Volvulus.**—Volvulus and twists or kinks in the intestine not due to adhesions and traction are essentially of the mural type, though perhaps a little less definitely than those cases resulting from a growth in the wall or stricture following ulceration.

Case of intestinal obstruction due to a traumatic rent in the mesentery. In May, 1904, the patient, a woman aged 45, fell and struck her abdomen

which had been ingested twenty-four or thirty-six hours previously. On March 7, 1907, total obstruction supervened. The abdomen was opened and a piece of gut 8 feet long was found to have passed three times through a rent in the mesentery and so produced twists of the gut in two places. The coils of gut were returned through the rent, the twists were reduced, and the rent in the mesentery stitched up. The patient made an uneventful recovery. J. B. Carnett (Univ. of Penna. Med. Bull., vol. xxii, No. 5, 1909).

Volvulus, which is responsible for about 15 per cent. of the acute cases

of intestinal obstruction, occurs twice as often in males as in females, and especially about the fourth decade, though it may occur even later. In fully one-half of the cases it is situated at the sigmoid, next in the region of the cecum or some portion of the small intestine. In this condition a loop of bowel is simply twisted on its long axis or one loop may be twisted about a loop developed from another neighboring coil.

In the not infrequent cases in which volvulus is due to a *mesosigmoiditis*, the symptoms are not well marked. In the writer's case the pulse was still good over 2 days after the onset, and pain was limited to the left fossa. There was diffuse ballooning, with protrusion in the midline and depression on both sides. Resection and anastomosis with a Murphy button were performed, and 6 weeks later the bowel appeared normal in size and activity under X-ray examination. U. Stoppato (Arch. ital. di chir., Aug., 1924).

**Tumors.**—These are more likely to give rise to chronic types, though the termination may be perhaps acute. Tumors growing from the wall of the bowel may be benign or malignant. Rarely pediculated benign tumors have become separated and have later passed *per rectum*. In the majority of instances malignant tumors are epitheliomas (cylindrical carcinoma), usually annular, occasionally circumscribed. The rectum, or one of the flexures, particularly the hepatic or the sigmoid, is the most common site. It is, therefore, more common in late adult life, more often in males, though recently a case of carcinoma of the sigmoid in a man of 30 came under my observation. Sarcoma is much less common, more apt to occur in children, usually of the

small lymphoid cell type, and especially apt to involve the small intestine.

Vascular tumors of the intestine grouped into 4 classes: (1) Multiple tumor on the vascular arcades, appearing as small red nodules in the submucosa; (2) submucous tumor, which grows toward the lumen of the gut and may ulcerate the overlying mucosa by pressure and trauma; (3) submucosal tumor, which may grow to such a size that it either obstructs the bowel or causes a change in normal peristalsis and brings about intussusception; (4) diffuse ring-like tumor, involving the muscularis and constricting the lumen of the gut. A. J. Brown (Surg., Gyn. and Obst., Aug., 1924).

**Strictures.**—These may be congenital or acquired. The former are very rare and comprise cases of imperfect anus or congenital defect in the terminal portion of the bowel, or failure of union between the pylorus and duodenum. Acquired strictures are those resulting from previous ulceration, dysenteric, typhoid, tuberculous, syphilitic, or, indeed, any cicatricial ulcer.

To the congenital malformations of the bowel oftenest recorded as causes of ileus, *viz.*, rectal or anal atresia, diaphragmatic hernia and diverticula of the small intestine, the writer adds, from personal observation, instances of atresia of the jejunum, constriction by the mesentery, intermittent and chronic volvulus, and strangulation near the cecum by a peritoneal band. Jejunal stenosis and atresia are usually located in the region of the duodenojejunal angle; obstructions of the ileum, generally just above the ileocecal valve. Congenital occlusion may be due, among other conditions, to vascular and inflammatory obliteration, peritonitis, tumor, and embolism. The prognosis is improved by surgical intervention. Cases not treated surgically always died within 13 days.

after birth. Dahl-Iversen (Lyon chir., Sept.-Oct., 1922).

Case of strangulation of a loop of ileum through a *mesenteric defect* in a girl of 9 years. This condition, because of fever, high pulse and leukocytosis, has several times been diagnosed as appendicitis. The openings in the mesentery are generally congenital, rarely traumatic. Severe pain and vomiting with other evidences of obstruction should be early recognized as suspicious. Marked strangulation and early gangrene result. The treatment is prompt laparotomy and reduction; the earlier the operation, the greater the chances of reduction and the lower the ratio of resections, the mortality thereby diminishing. In severe cases with gangrenous intestine the writer advises resection and drainage at a 1st operation, and later anastomosis. G. D. Cutler (Boston Med. and Surg. Jour., Feb. 12, 1925).

**Coprostasis; Gall-stones; Enteroliths; Foreign Bodies.**—Obstruction due to intramural causes are perhaps most commonly fecal impaction (coprostasis), and, while this is most apt to be chronic, it sometimes develops acutely. The acute obstruction is most frequent in the sigmoid or cecum, usually in the aged, debilitated or melancholic, or actually insane individuals. Gall-stones which have ulcerated through into the intestine usually obstruct at the ileocecal region or at the duodenum. Obstruction is very rare if ulceration takes place into the colon. Enteroliths due to the impregnation of fecal matter by magnesium and calcium oxalate or phosphate, or depositions upon gall-stones or other foreign bodies, or foreign bodies consisting of stones of fruit, buttons, coins, or round worms, may obstruct the bowel, or magnesia or bismuth taken medicinally may accumulate and cause obstruction.

Two tumors with a tender zone between, all in the descending colon, proved to be an accumulation of 712 cherry stones. No cherries had been eaten for several months, and microscopic examination at necropsy revealed incipient malignant disease. The latter had probably interfered with normal peristalsis. A. Kotzareff (Revue méd. de la Suisse rom., Oct., 1918).

In 15 cases of ileus from gall-stones, the total operative mortality was 53 per cent. In 1 instance the gall-stone was felt by palpation through the vagina and rectum, and the operation disclosed it in a loop of small intestine in the pouch of Douglas. In another case, the calculus was as large as a hen's egg, and of pure cholesterol. Gutierrez (Rev. de Cir., Apr., 1924).

Case in which roasted chestnuts caused incomplete intestinal obstruction. The intestine below the site of impaction was collapsed. The patient had swallowed the roasted chestnuts whole. They had been unaffected by the digestive ferments over a period of nearly 10 weeks. A. G. Bryce (Lancet, Jan. 3, 1925).

**Intestinal paresis, postoperative obstruction, or paralytic ileus**, so-called, can scarcely be grouped under any of the above headings, though it is essentially a condition resulting from more or less widespread paralysis of the muscular walls of the bowel, so that no peristaltic action can occur, and an obstruction, therefore, results. This is seen in those desperate cases of embolism or thrombosis of the mesenteric vessels previously described under the head of intestinal infarcts. It may occur, too, after injuries, especially blows upon the abdomen, or following operations, chiefly abdominal.

Rarely intestinal paresis follows tapping for the removal of abdominal fluid, occasionally in pleurisy, somewhat more frequently in pneumonia,

and rarely in cases of cardiac decompensation, particularly in those in which the liver has become very large. Rather rapid distention of the abdomen occurs, due to cessation of peristalsis, with the advent of obstructive symptoms. Hysterical patients may likewise manifest pseudo-obstructive symptoms.

The following are the etiological factors for postoperative ileus: (1) mechanical irritation of the peritoneum and intestine during operation; (2) infections of the peritoneum; (3) adhesions of the intestinal loop to abraded surfaces or to adhesion strands; (4) closure of mesenteric vessels. The postoperative distention which is nearly always present is likely to be a signal of danger. E. W. Pinkham (Amer. Jour. of Obstet., lxxvii, 614, 1918).

In 14 out of 16 cases of obstruction in the small intestine the writer found loops of the small bowel in Douglas's cul-de-sac on rectal palpation. On the other hand, in none of 4 cases of obstruction of the large intestine could such loops be palpated. The author regards this as a useful diagnostic test for small bowel obstruction. E. Gold (Mitt. a. d. Grenzg. d. Med. u. Chir., xxxviii, 78, 1924).

Case of obstruction due to *adhesions* in a woman of 31. Gradually increasing constipation had followed an acute abdominal attack (probably appendicitis) at 13. At operation the appendix was found buried in adhesions, greatly thickened and strictured. Aside from many adhesions between the cecum, ascending colon, omentum, gall-bladder and duodenum, the ileum was matted in a 10-inch mass near the ileocecal valve and in a smaller mass higher up. Over each mass was a fibrous membrane free of external adhesions. The writer separated the contained loops from these sheaths and also freed the colonic and other adhesions, revealing a normal duodenum and gall-bladder. A. H. Burgess (Brit. Med. Jour., Apr. 26, 1924).

Intestinal obstruction attended *appendicitis* in 34 out of 1011 operated cases. It was primary in 13 cases, without any deaths, and postoperative in 21, with a mortality of 33 per cent. In addition, there occurred in some other cases a condition of loculated fibrinopurulent peritonitis associated with a certain amount of obstruction in which death was perhaps more from peritonitis than obstruction; these cases had a very high mortality. R. Warren (Bristol Med.-Chir. Jour., Jan., 1925).

Three cases of *spastic ileus* following abdominal contusion with intraperitoneal hemorrhage. There was abnormal instability of the vegetative nervous system in each instance, and toxic injury of this system is regarded as having been the cause of the spasm. A diagnostic feature of spastic ileus is the very slight disturbance of the general condition. In mild cases the treatment is conservative; in more serious cases, prompt *laparotomy*, possibly with *irrigation*, is advised. Reimer (Arch. f. klin. Chir., Apr. 30, 1925).

**PATHOLOGY.**—There are three types of intestinal obstruction: First, and most frequent, the acute variety. Second, chronic intestinal obstruction. Third, acute obstruction engrafted upon a chronic. In the acute type, in which the lumen is suddenly and completely blocked, in the majority of instances, there is an associated strangulation, with consequent interference with vascular and nerve supply. This brings about, at the site and in the neighborhood of the obstruction, congestion, inflammation, and, if time is given, ultimate gangrene. The coils above the obstruction become dilated as a result of the accumulation of gas and feces, while below the obstruction the intestine collapses. In the chronic types, owing to the time element, opportunity is given for development of

more productive change. In consequence of the obstruction, there will be more or less hypertrophy and dilatation of the wall of the intestine above, with a narrowing of the lumen below the site of interference. The intestinal wall, and particularly the mucosa, is more or less involved above and in the neighborhood of the obstruction, becoming congested, ulcerated, and occasionally perforation or rupture, with subsequent peritonitis, occur. In the acute cases supervening on the chronic the changes are very similar to those described under the chronic type; that is, time having been given for productive phenomena in the bowel wall, but, in addition, acute inflammation or even gangrene may be superposed. Naturally, the findings will differ somewhat in view of the large number of possible causes, but in the main all of these gradations are comprised in the above statement. In those cases in which the circulation and nerve supply are interfered with, infection of both the strangulated loop and of the peritoneum takes place. There may be definite evidence of a diffuse peritonitis, with actual perforation, in consequence of the increased permeability of the strangulated loop. The strangulated loop is paralyzed, due to a combination of various circumstances, namely, interference with the blood-supply, injury to nerves, and, in part, as a result of distention. Vessels thrombose and the process eventuates in gangrene and perforation, unless relieved by operation.

With the toxemia of high intestinal obstruction characteristic changes occur in the chemistry of the blood: A rise in the blood urea, a fall in the

plasma chlorides, and a rise in the carbon dioxide combining power of the plasma. By a study of blood chemistry, the condition can be recognized early, the severity measured and the progress of treatment watched. Tetany may be anticipated when the  $\text{CO}_2$ -combining power exceeds 100 per cent. by volume. Sodium chloride, sugar and water are of value in treatment. All cases showing a tendency to alkalosis, alkali is contraindicated. McVicar (Amer. Jour. Med. Sci., Feb., 1925).

**PROGNOSIS.**—In the vast majority of instances this is a matter of diagnosis, in the acute types especially. The earlier operative interference is practised, the greater likelihood of successful issue. In the chronic types, when due to malignancy, the outlook, of course, is practically hopeless, though even here, if recognized very early, resection may prove beneficent for a time at least.

Those types resulting from tumors of any of the intra-abdominal organs, the extramural type, or upon abscesses in the pelvis or about the appendix, or on renal or pancreatic conditions, will depend, of course, upon one's ability to relieve the underlying cause. A serious condition, frequently rendered infinitely more so by failure to recommend immediate operative interference whenever the suspicion of obstruction arises.

**TREATMENT.**—The most important factor in the treatment of any case of intestinal obstruction, more especially of the acute type, is to avoid the administration of purgative medicines. Even cases of fecal impaction, which is the only form of obstruction of the bowel which is not essentially surgical, should not be treated by purgative medicines

until attempts have been made successfully, by means of enemas, to relieve the condition.

Treatment, therefore, becomes a matter, first, of determining whether the obstruction is acute or chronic, and, if **acute**, absolutely all forms are **surgical**, with the possible exception of two. These are, first, the so-called paralytic ileus, which may be remedied by **saline injection**, and the results in this condition are sometimes surprisingly prompt, or if intussusception is suspected, attempts may first be made by means of **irrigations** into the bowel of **sterile salt solution**, or through attempts at **inflation** to relieve the invagination. Before adhesions form, this may possibly be successful.

It must not be forgotten, however, that both *irrigations and inflation* are not without risk, and that, if employed at all, they *should only be used very early* in the course of the case, and the greatest care should be exercised, for overdistention may rupture the bowel, particularly if inflammatory softening has occurred. **Postural or succussion methods** likewise require care.

Two cases added to the few on record in which menacing post-operative ileus was arrested as if by magic by **turning the patient on his stomach**. The occlusion is the result of traction on the mesentery of the small intestine, which drags down with it the superior mesenteric artery as it crosses over the duodenum. Rosenthal (Archiv f. Gynäk., Bd. lxxxvi, Nu. 1, 1908).

Treatment of intussusception by the **combined taxis and succussion** method is always to be **preceded by a rectal injection of water** to obtain the best results. The method is as follows: After the child is anesthe-

tized, the abdomen is bared and the hips raised by a small pillow. The tumor is grasped through the abdominal wall and firmly compressed for a few moments in order to reduce the swelling. Then the thighs are flexed on the abdomen, knees or legs grasped, and with a rapid up and down movement the lower part of the trunk is vigorously shaken for several seconds. The tumor is grasped again and compressed, and, while pushed against any part of the posterior abdominal wall, the fingers push or strip the intussusciens out of the intussusceptum, the fingers at the same time making a trembling motion which assists in the reduction. After a few minutes of taxis the succussion is again resumed, and these efforts successively alternated. Sometimes, because of the mobility of the mass, taxis is not effective, and reliance must be placed entirely on the succussion or shaking. In all cases noted the tumors disappeared while the shaking was being done, although taxis had diminished the size of the swelling. J. Zahorsky (Arch. of Pediat., vol. xxviii, p. 380, 1911).

The diagnosis of obstruction once made or even strongly suspected, **operation** should be resorted to as promptly as possible. Until this can be done, **washing out the stomach with warm salt solution** may relieve vomiting and some of the distention which exists above the site of obstruction.

As to the propriety of using **opiates**, no harm will follow if operative interference has been decided upon, but great damage will be done if they are used to the point of obtunding the patient's sensorium, with the production of what might be called a period of deceitful calm. **Morphine**, hypodermically, and **gastric lavage** will allay pain and vomiting and prevent dangerous distention, and, in conse-



quence of this latter result, lessen some of the effects of vascular compression and spare the integrity of the bowel until the operation can be performed. The use of **atropine**, internally, may also be resorted to,  $\frac{1}{80}$  grain (0.0013 Gm.) or even  $\frac{1}{25}$  grain (0.0025 Gm.) by mouth, two or three times in 24 hours being given.

Three cases of severe post-operative ileus;  $\frac{1}{64}$  grain (0.001 Gm.) of **physostigmine salicylate** was injected and immediately vigorous peristalsis was induced. Goth (Zent. f. Gynäk., Dec. 19, 1908).

**Atropine** found of value in 8 cases of paralytic ileus. In 2 patients already in *extremis*, it was of no avail. A. Lederer (Med. Klinik, Jan. 2, 1910).

In postoperative ileus the writer always gives **pituitary extract** intramuscularly, 1 c.c. (16 minims) being repeated every hour up to 3 doses, then every 2 hours, not exceeding 5 doses in 24 hours. This may be reinforced by a suitable enema. Gibson (Annals of Surg., Apr., 1916).

**Transfusions of dextrose solutions** are often of benefit in intestinal obstruction. Cooke, Rodenbaugh and Whipple (Jour. Exper. Med., June, 1916).

In acute obstruction due to worms, not relieved by purgatives given orally, a **purgative enema** will often bring relief. Perret and Simon (Jour. Amer. Med. Assoc., Jan. 27, 1917).

In 245 cases the mortality in cases operated on in 12 hours was only 5 per cent. The indications for **operation** are intestinal type of vomitus, failure of lavage and enemas, and an increasing pulse rate with restlessness and thirst. Finney (Surg., Gyn. and Obst., May, 1921).

The treatment of intussusception in infants is **water pressure** preparatory to X-ray location of the trouble; barium solution by rectum, and **gentle massage** of the tumor. If this fails, **immediate operation** is indicated. A case in a 6-months' infant exhibited a mass in the upper right quadrant.

Water pressure failed and operation was done within 12 hours. The bowel was already almost gangrenous, but prompt recovery followed. T. E. Craig (Ky. Med. Jour., Nov., 1922).

Dogs with obstruction of the duodenum were kept alive 27 and 28 days by daily saline hypodermoclysis, while controls receiving distilled water instead died in 3 or 4 days. Two human patients, 1 with pyloric and the other with small intestine obstruction, showed marked improvement from **sodium chloride**. In acute obstruction 1 Gm. (15 grains) of salt per kilo of body weight should be given as the initial dose and enough salt then given daily to keep the NaCl of the blood within normal limits. R. L. Haden and T. G. Orr (Jour. Amer. Med. Assoc., May 10, 1924).

In post-operative paralytic ileus, the writer gives a slow intravenous infusion of 500 to 1000 c.c. (1 to 2 pints) of physiologic **saline solution** with 4 to 8 c.c. (1 to 2 drams) of **pituitary extract**. The bowels soon moved in 70 per cent. of his 52 cases. A. Mayer (Munch. med. Woch., July 11, 1924).

Among the most difficult of all forms of acute obstruction to recognize are the internal hernias; indeed, one may say impossible of recognition clinically, and often requiring patient search on the operating table. For the surgical treatment of intestinal obstruction, see Volume I, page 62.

## VISCEROPTOSIS.

**SYNONYMS.**—Glénard's disease; enteroptosis; splanchnoptosis. Descriptive of displacements of individual organs are the following terms: Nephroptosis, coloptosis, splenoptosis, hepatoptosis.

**DEFINITION.**—A dropping or falling of any or all of the abdominal viscera. In the majority of instances the stomach alone, or the stomach and right kidney, occupy lower posi-

tions than normal, and probably about as frequently as these the transverse colon is displaced downward. In some instances, however, all of the viscera come to occupy a lower position than normal.

**SYMPTOMS.**—Two groups of cases are found to exist, one in which the condition is acquired and the other in which it is congenital. The acquired cases often have a normal type of thorax, with a wide intercostal angle. These are, in the vast majority of instances, women who have undergone multiple pregnancies, or men or women who have been corpulent, but, having lost their fat, exhibit relaxation of the abdominal wall. The acquired types, whether occurring in men or women,—usually the former,—have a thorax of a tuberculous type, long vertically, with an acute intercostal angle and very little space between the last rib and the iliac crests. In general, patients with the acquired type complain especially of gastrointestinal disturbances, while those with the congenital type are apt to be classed among the neurasthenics. It is a curious fact that in some cases with very moderate ptosis marked general phenomena may be present, while others with the same or even a greater degree of ptosis may not be conscious of ill health, except that they note a tendency to exhaustion on slight exertion.

Visceroptosis is such a common condition that it furnishes the strongest argument for routine physical examination, both of the chest and the abdomen. It is not at all unusual for an individual the subject of this condition to pass through numerous hands, medical and even surgical, without the true nature of the condi-

tion being discovered. Faulty nutritional states, dyspepsia, constipation; vague pains throughout the body, backache, neurasthenia, fainting sensations after standing for any length of time, or more or less exhaustion after slight effort,—any or all of these may occur without recognition of the true cause. From the standpoint of the gastrointestinal tract the following manifestations are to be observed: Anorexia or a capricious appetite; a sense of distention, usually epigastric, occurring after meals; nausea, with or without vomiting; gaseous eructations; sometimes pyrosis and burning sensations beneath the lower end of the sternum or in the epigastrium, together with constipation, either alone or alternating with diarrhea, and in some instances mucous colitis. Cardiovascular symptoms are: Palpitation, cardiac irregularity from vagal irritation, vertigo, sensation of faintness, marked flushings, and pallor. The nervous phenomena are apt to be most bizarre. Often the dominating picture is that of the neurasthenic, with insomnia, melancholia, or periods of depression, alternating with brief periods of buoyancy, headache, and one very common complaint which may or may not be of nervous origin, viz., a dragging sensation with pain in the back and loins.

Patients with visceroptosis often state that they feel well from the waist up, but absolutely miserable below the waist. Probably many of the phenomena can be explained by disturbances in the abdominal circulation due to tension upon the vessels the result of prolapse, with consequent lowering of the organic function; in addition, there are likely

to be present symptoms resulting from vasomotor disturbances due to stretching of the splanchnics, as well as cardiac disturbances or motor disturbances of the stomach and small bowel, induced by vagus irritation. Cold hands and feet are the rule, and patients with this condition are apt to complain bitterly of the cold; the skin may even be clammy. One comes to associate a certain type of facies and physical conformation with visceroptosis. When the condition is of long standing, the patient is either absolutely apathetic or careworn and more or less wrinkled.

Very rarely one meets with a case in which a mechanical factor is responsible for the development of exquisite pain,—the so-called "Dietl crisis," simulating renal colic. This results from twisting of an unusually loose kidney upon its pedicle, with consequent torsion of the vessels, ureter, and nerves; intense lumbar pain, frequently radiating like that of renal colic. Chills, fever, nausea, vomiting, and collapse may occur. The urine, lessened in amount, may even occasionally be totally suppressed, and on examination the kidney may be found to be increased in size and tender (protopathic). Occasionally temporary hydronephrosis may add to its size. After the cessation of the attack, there may be an unusually large volume of urine; the urine often contains blood.

In the majority of women, even those who have never borne children, and in a small proportion of men, the right kidney may be felt on palpation during deep inspiration. This can scarcely be looked upon in itself as abnormal. When the organ is preternaturally movable, however, and

especially when the upper pole can be felt, the condition is to be regarded as distinctly pathological. This is best determined by placing the left hand over the flank, lifting the posterior abdominal wall up, with the patient in the recumbent position and well relaxed, while the fingers of the right hand are placed over the anterior abdominal wall, below the costal margin. The two hands are moved toward one another sharply during expiration. In this way, even in a stout person, slight mobility, of the right kidney especially, may be determined.

In the diagnosis of gastroptosis the writers stress the value of fluoroscopy first with the stomach empty, then after 1 swallow of the opaque material, and again after the whole amount has been taken. To ascertain what may be expected from a supporting device they have the patient push up his stomach with both hands. T. Martini and J. Comas (*Prensa med. Argent.*, Aug. 20, 1924).

Gastroptosis often exists without dilatation, but in the atonic cases more or less dilatation may be present. The stomach is vertical, often largely to the left of the vertical median line, and unless the pylorus is held up by adhesions it may come to occupy almost any position in the abdomen. The greater curvature, normally just above the transverse umbilical line when the stomach is empty, may under normal conditions be 1 inch or even 2 inches below the umbilical line after a meal, but in visceroptosis it may be actually down to the pelvis. Very light and superficial percussion is the best method to practice in order to outline it. Splashing sounds can in most instances be elicited for a considerable period after a meal.

The colon is much more difficult to outline; indeed, this is frequently impossible. If, as is sometimes the case, it is contracted, it may be felt, but this is quite the exception. It may be ptoised in the form of a "U" loop or a "V," in which case it is apt to form a sharp kink, especially at the splenic flexure, which, with the spleen, constitutes the area the least often disturbed of any of the abdominal viscera.

The liver is only exceptionally displaced, and can be outlined by very superficial percussion from above downward, or by placing the fingers of the left hand over the loins and the thumb anteriorly below the right costal margin while the right hand is used to make pressure upon the anterior abdominal wall, forcing up the viscera so that the anterior edge of the liver can be brought forward. In this way during inspiration the edge of the liver will ride over the thumb of the left hand. Occasionally Riedel's lobe, an abnormal, tongue-like process of the liver, may be felt anteriorly, giving the impression of a displaced right kidney or an enlarged gall-bladder. When the liver is markedly prolapsed, the cystic duct becomes more or less kinked and the common bile-duct also becomes obstructed to some degree, as shown by the late J. Dutton Steele. Thus are explained the various grades of jaundice occurring in this condition.

Occasionally, as was described in the section dealing with intestinal obstruction, gastrosesenteric ileus may result through compression of the last portion of the duodenum by the root of the mesentery and its blood-vessels in consequence of extreme traction in advanced ptosis.

The pancreas may occasionally be felt if the patient can tolerate deep palpation in the epigastrium, midway between the xiphoid and umbilicus.

The cecum, particularly in long-standing cases, is often dilated and in the majority of instances falls over the brim into the pelvis. Bimanual examination in women will demonstrate a very low position of the uterus and the adnexa, the uterus often retroflexed, the fundus being felt in the *cul-de-sac*, the vaginal vault being less roomy than normally, with bulging of the anterior wall.

The abdominal wall in the majority of instances lacks tension, is unusually lax and quite redundant in the acquired forms, while in the congenital types there is a good deal more tension, no redundancy, and a scaphoid shape with prominent iliac spines. Even though the recti in any of these conditions may be capable of firm contraction, it will be found that the lateral walls, particularly, are utterly lax. Tender areas may be elicited here and there, and vasomotor paresis can be shown by the red line which occurs on the abdominal wall after scratching or other form of irritation. The lack of lateral abdominal musculature can well be shown, especially in those whose recti remain more or less normal, when in an attempt to rise from the recumbent position the intra-abdominal strain forces out the lateral walls, producing more or less bulging at the sides. In the congenital types especially there is an absolute lack of fullness in the epigastric region, or even a marked incurving. In the erect position the visceroptotic individual will show more or less prominence and fullness below the

transverse umbilical line, with flattening above.

In the congenital types, especially where visceroptosis is general, the diaphragm is depressed and the heart in consequence comes to occupy a lower position than normal. Probably as a result of this, the structures at the base and necessarily in the neck are subject to more or less traction, so that during cardiac systole a visible tug may be manifested, and during inspiration the cervical veins fill instead of empty, as shown by Wenckebach.

In marked cases there is very apt to be sighing respiration and the respiratory movements are suprathoracic, the lower portion of the thorax and epigastrium being motionless. In very thin individuals coils of small intestine may be visible, as may peristalsis.

X-ray examination renders a definite diagnosis a simple matter. An opaque meal and a series of plates will reveal not alone the position of the various coils, loops, and flexures of the intestine, but also the time necessary for the passage of food through both small and large bowel, and in successful plates even solid organs may be outlined when the picture is taken after a purge, on a fasting stomach, and before the opaque meal is administered. Gastric motility and the presence of kinks are easily revealed. Plates are not really necessary if one possesses a good-sized fluoroscopic screen.

The writer observed at Vichy a group of cases with combined *hepatoptosis* and liver disease, infectious (typhoid, malaria) in 9, toxic in 19, traumatic in 28, and nervous (grief, fright, overstrain) in 12. The liver congestion impeded portal circulation and pro-

moted enteroptosis, both mechanically and through impaired liver function. The **Vichy waters**, greatly improving the liver, seemed to overcome the ptosis at the same time; **sodium sulphate** in laxative doses and a **supporting girdle** are also advised. Glénard and Rouzaud (Paris méd., June 25, 1921).

Liver ptosis may cause painful attacks, with or without jaundice, simulating hepatic colic. They are usually due mainly to traction on the bile ducts and angulation of the neck of the gall-bladder. Losio (Policlin., Feb. 21, 1921).

Two cases of duodenal kink with consequent gastric stasis and symptoms and 2 of compressed colon and sagging hepatic flexure, both of these types of cases being due to ptosis of the liver. **Hepatopexy** proved beneficial in these cases. Fasano (Policlin., Jan. 15, 1923).

**DIAGNOSIS.**—A knowledge of the two types, with the characteristic facies and a careful physical examination, will reveal the presence of ptosis of any or all of the organs. Nothing is to be gained by gastric analysis except in those instances in which dilatation with or without retention occurs. Early, gastric hyperacidity is the rule, though later free hydrochloric acid may be diminished or absent, and in few instances achylia gastrica occurs. It is no longer necessary to practise inflation of the hollow viscera, particularly the stomach, as the X-ray makes absolute diagnosis an easy matter. The definite relation between a floating tenth rib and visceroptosis to which Stiller called attention probably does not exist.

Two signs are associated directly with prolapsed intestine by J. W. Smith: 1. A tender point in the right semilunar line, generally an inch or so below the level of the umbilicus, but above McBurney's point.

The tenderness is most marked on palpating backward and slightly inward toward the base of the transverse processes of the vertebrae. 2. A succussion splash in the "cesspool cecum"—very frequent and almost pathognomonic. In advanced cases there is pain across the lower abdomen, between the iliac fossae. Often, pulsation of the abdominal aorta in the epigastric region is very marked.

Dull abdominal pain or "feeling of weight" often accompanies the erect attitude and is relieved by lying down.

Important clinically is the secondary implication of the stomach, leading to predominance of gastric symptoms.

A diagnosis of visceroptosis is one only too easily made on insufficient evidence, and which is only too readily accepted by the patient. Before attempting any treatment for it, other organic lesions such as peptic ulcer must be excluded as far as possible, and the diagnosis should never be made apart from radiographic evidence. Again, even some perfectly healthy individuals have ptosis of the stomach or colon. J. J. Conybeare (Lancet, Oct. 3, 1925).

**ETIOLOGY.**—In considering the causes of visceroptosis it is necessary to bear in mind the two distinct types. The congenital type, with long, narrow, acute-angled thorax, prominent second rib, and other more or less pronounced manifestations of a phthisical conformation, can easily be shown to exist in several members of the same family, almost without exception with an ancestral tuberculous history.

The acquired type of ptosis results from repeated pregnancies, hydramnios, removal of enormous abdominal tumors, and improper corsets or tight lacing; or, in men and women alike, it may result from obstinate chronic constipation, prolonged coughing as in bronchiectatic individuals, after possible recovery from

ascites, and after the absorption of subcutaneous and intra-abdominal fat such as occurs after long wasting diseases. Diastasis of the recti, unless of tremendous degree, is not sufficient to invite the condition unless there is associated relaxation of the lateral muscle group, viz., the transversalis and obliques.

Whatever be the primary cause of visceroptosis, the end-result of the fall of the viscera and the stretching of the ligamentous attachments, with traction on vessels and nerves, is the same. Accumulation of blood in the abdominal venous system accounts for the cerebral anemia and syncopal attacks; or, when the condition is less marked, a sense of faintness occurs, especially when the patient is on her feet a great deal. This may also explain the insomnia complained of by many.

It has often been observed that the visceroptotic woman markedly improves during pregnancy, being totally relieved of her symptoms and even gaining weight.

The explanation of this event is twofold: The improvement is in part due to the lifting up of the viscera, and in part also to restoration of the function of the diaphragm; in consequence of these changes a restoration of the circulation takes place.

The part played by the pelvic floor in supporting the abdominal viscera is almost a negligible one. The repair of perineal lacerations need not, therefore, be given consideration in the management of a case of visceroptosis.

Rarely, long-continued intrathoracic conditions, as large exudates, new growths, or rarely a pneumothorax, may cause ptosis of the abdominal

viscera by fixing the diaphragm in the inspiratory position, thus interfering with its respiratory function and, in consequence, rendering more or less useless its muscular opponents, viz., the muscles of the abdominal wall.

In the more frequent type of chronic manifestations of *mobile cecum* and ascending colon, complaint is made of chronic constipation and pain and tenderness in the right iliac fossa, more pronounced on exertion after ingestion of food; there is also flatulence and epigastric discomfort. X-ray examination after a barium meal and enema gives confirmatory evidence. Putrefaction with chronic catarrhal colitis tends to produce toxemia. In the treatment, the writer adopts the method of **plication**. After removal of the appendix, a continuous suture of fine thread picks up the anterior and lateral longitudinal teniae from the base of the appendix, and is carried as far up the ascending colon as the dilatation requires. J. Morley (Brit. Med. Jour., Oct. 9, 1920).

Case of mobile ascending and transverse colon in a girl of 16. She had had 3 attacks of sudden pain in the lower abdomen, settling down into the right iliac fossa, with constipation, fever, dry tongue and rapid pulse. At operation the cecum and ascending and transverse colon were found on the left side, covered with small bowel. They had no mesentery. The appendix showed evidences of recent inflammation and was removed. T. A. B. Harris (Lancet, Sept. 13, 1924).

**Mechanism.**—Frantz Glénard first called attention to this condition in an exhaustive paper embodying his experiences at Vichy. He suggested for the disturbance the name *enteroptosis*, but Ewald preferred the term *splanchnoptosis*, because in fully developed cases not only the abdominal, but also the thoracic, viscera are the subject of more or less displacement.

We owe much to Dr. Arthur Keith for his splendid embryological and anatomical studies of this condition, and his findings have been largely drawn upon in the following: To appreciate the abnormal presupposes a recognition of the normal, and to this end certain boundaries and surface markings have been devised. Chief of these is the *sternoensiform line*, a transverse line passed through the junction of the sternum with the xiphoid. This marks the normal upper limit of the abdominal organs. The domes of the liver on the right and left sides fill the outer portions delimited by this line with the patient in the recumbent position, and fall a trifle below it when the individual is erect. The central tendon of the diaphragm lies about  $\frac{1}{2}$  inch below the line, a little to either side of the median vertical line of the body. This line forms the basis of measurement by which we estimate the extent of actual ptosis. Normally it crosses the fifth costal cartilage on each side; the fifth space in the emphysematous, in which case the ribs are more horizontal, and the fourth interspace or even the fourth rib in the phthisical type of chest, in which the position of the ribs is very oblique, with a narrow intercostal angle. The second landmark, known as the *transpyloric line*, was described by Dr. C. Addison. It is a transverse line passing through a point midway between the umbilicus and the sternoensiform line, the so-called midepigastric point. Normally, this line meets the costal margin near the outer border of the rectus muscle of each side, crossing the ninth cartilage. In its normal position the pylorus is found immediately under this line.

about midway between the midepigastric point and the right costal border. Abnormally, the pylorus may come to occupy almost any position, as has previously been stated, but the actual degree of displacement can be determined from the above facts. The lesser curvature is normally  $\frac{1}{2}$  to 1 inch above the transpyloric line, and the greater curvature in the midline of the body,  $1\frac{1}{8}$  to  $1\frac{1}{2}$  inches below it. Behind the line lies the pancreas, and normally the liver is always above it. The third line is one drawn transversely through the umbilicus, the so-called *transverse umbilical line*, which is almost identical with the line drawn across the highest points of the two iliac crests. Normally, the transverse colon occupies a position in the midline just above this landmark. The right kidney is normally situated a little lower than the left, but its lower pole is  $1\frac{1}{8}$  inches above this line, and in the case of the left kidney  $1\frac{1}{2}$  inches above. Abnormally, the lower pole, of the right kidney especially, may be felt below this line, tilting toward the median vertical line of the body.

In the recumbent position the upper border of the liver on the right side reaches the sixth rib in the mid-clavicular line, anteriorly the eighth rib in the midaxillary line, and posteriorly the tenth rib in a line with the inferior angle of the scapula, while its lower border anteriorly is delimited by the costal margin. The hepatic flexure of the colon is just within the right anterior axillary line under cover of the tenth and eleventh costal cartilages and liver, its upper border being just below the transpyloric line. The splenic flexure extends above the transpyloric line on

the left side, just within the left anterior axillary line, and with the spleen and left kidney constitutes the most fixed region within the abdomen.

Various factors have been brought forward to account for the normal maintenance of position of the abdominal organs. By some, the ligaments are held to be of the greatest import. That this is erroneous, however, can be readily shown by holding a cadaver in the erect position. Provided the body is not frozen or at least cold enough to render rigid the abdominal wall, it will be found that the viscera chiefly concerned in ptosis, viz., those above the transverse umbilical line, at once prolapse. If now the abdominal walls are cut and reflected, though the ligaments remain intact, more marked ptosis occurs. This I have observed some hundreds of times in the making of necropsies, and it seems conclusive evidence that the chief factor must be the abdominal wall. Were the ligaments responsible, the erect position would of necessity cause traction during life, with consequent disturbance of both vascular and nervous structures contained within them. As has been previously stated, the muscles mainly concerned in this support are the transversalis and obliques. This can be best observed in the individual whose recti happen to remain in normal tonus while the lateral muscles wholly or in part lack their tonus. When such an individual attempts to rise from the supine to the sitting posture without using the hands, it will be noted that the lateral regions yield very materially, causing prominences to appear on each side. Likewise during coughing, with an intact abdominal wall the supraumbilical



viscera during forced expiration are driven up into the hypochondriac region, forcing the diaphragm upward and compressing the thoracic viscera, while the infra-umbilical viscera are forced downward. With lax muscles which have lost their tonus, this does not hold true.

The study of a case of visceroptosis is best accomplished by theoretically dividing the abdomen into two portions, with the transverse umbilical line as the dividing line separating it into supra- and infra- abdominal regions. The organs in the upper area, viz., the stomach, duodenum, transverse colon, kidneys, especially the right, in some instances the liver and pancreas, and very rarely the spleen, are the parts especially involved. Normally, too, the muscles of the abdominal wall in the upper area act as opponents of the diaphragm, so that as Keith states, in thoracic respiration these muscles serve under normal conditions as a shelf or support for the contained viscera during inspiration, thereby aiding the diaphragm. The muscles of the infra-abdominal region normally play a minor part in breathing, but they do furnish some support for the supra-umbilical contents.

According to some observers, the position of the stomach matters little provided its tone is satisfactory and intra-abdominal pressure is normal. Patients with an extremely low stomach may, indeed, not suffer from indigestion. In the slender, flat or narrow-chested type of person, this organ may often be found in the left lower abdominal quadrant.

The symptoms usually ascribed to gastropoptosis may be due to many causes, both intra- and extra-gastric,

and are the same without relation to the position of the stomach. Of 551 cases with the lower border of the stomach more than 2 inches below the umbilicus, 200 had indicanuria and over  $\frac{2}{3}$  were constipated, suggesting that intestinal toxemia is an important factor in the symptoms. Undernourished patients should be given treatment to improve nutrition and develop all muscles, particularly those of the anterior abdominal wall. On account of the usual chronic fatigue, psychic treatment is very helpful. The patient must be taught to take a full diet, with plenty of butter, cream and other fats, of the starchy and green vegetables, and 1 or 2 quarts of milk a day. Rest in bed for 4 to 6 weeks is necessary in many cases. A system of exercises is then taught the patient, involving every large group of voluntary muscles. The abdominal supporter is regarded only as a temporary measure. S. Harris and J. P. Chapman (Jour. Amer. Med. Assoc., Nov. 25, 1922)

**PATHOLOGY.**—It cannot be stated that there is any definite pathology other than the relaxation of the musculature of the abdominal wall, and in time also impairment of the diaphragm. The involved viscera may become congested, and the liver especially may become additionally enlarged on that account. In advanced cases the stomach may become atonic and dilated.

**PROGNOSIS.**—The milder grades, particularly those which are acquired, yield more or less readily to appropriate treatment, so that, in general, the statement is justifiable that the prognosis is good. In the congenital types, however, the outlook is less favorable. Recovery depends in so large a measure upon the volitional aid of the patient, and this is so difficult to obtain in many instances, that a rather larger proportion of these

individuals drift into a state of more or less complete invalidism, and unfortunately the profession at large so seldom recognizes the true nature of the case that finally, in addition to the morbid entity, the patient may be said to suffer also from a complication of doctors.

**TREATMENT.**—The management of a case of visceroptosis depends, in part at least, upon the type of abnormality present. In the acquired form **mechanical support** that really accomplishes its purpose will give very prompt relief. As the nervous manifestations are usually less pronounced than in cases of the congenital type, it will usually prove sufficient to apply a well-fitting **binder**, such as the Rose or the Storm binder, or even a **two-piece corset** of which the lower portion constitutes an abdominal belt, or a corset in one piece provided with an abdominal binder which fits inside the corset, passing out through perforations, so as to permit of adjustment. The Spencer corset is an excellent illustration of this type.

In cases of moderate severity, the author's patients, while permitted to follow their usual activities, take 3 small meals during the day, the principal meal being eaten at night and the patient going to bed immediately thereafter (**vesperal digestion in the reclining position**). The small meals consist of small amounts of liquid or soft foods that pass rapidly through the pylorus and exert a pronounced stimulating action in comparison to their bulk, *vis.*, raw meat, eggs, sugar, etc. The large evening meal, on the other hand, consists of bulky and nourishing but unstimulating foods. P. Carnot (Paris méd., Apr. 5, 1924).

In the weak and exhausted cases **rest in bed** for some time may be

necessary, and it is often advantageous to **elevate the foot of the bed**. After relief has been procured from the results of abdominal and pelvic congestions, a well-fitting **binder** should be applied and the patient allowed to get up. **Correction of any constipation or digestive disturbance** should be effected, and for a considerable period it will be necessary for the patient to secure ten to twelve hours' **rest** daily.

In prolapse of the cecum a kink is sometimes formed in the ileum near the ileocecal valve. Fermentation takes place and the entire small intestine may become distended, producing discomfort or severe pain. In the treatment of this condition **licorice powder** is of great service, especially in conjunction with a diet largely of vegetables; likewise, **agar-agar**.

In cases in which colitis is present small doses of **phenyl salicylate** and **castor oil** are of value, and when toxemia exists great help is afforded by the exhibition of **calomel** once a week. J. M. Jackson (Boston Med. and Surg. Jour., Sept. 12, 1912).

The congenital type, and less frequently the acquired type, present a nervous symptom-complex which is often one of the most difficult of the entire condition to deal with. Mechanical supports, such as the usual binder or corset, are frequently of no value in this type, owing to the prominent iliac bones and scaphoid abdomen. Under these circumstances support can be obtained only by the application of **adhesive plaster straps** wider at their lower anterior end than at the upper and posterior. They should be long enough to cover about three-fourths of the body circumference, and the first should be applied in the iliac regions, to the right, to be carried beneath the left iliac crest

and passed beyond the spine posteriorly. The corresponding opposite strap should be placed over the left iliac region, and carried obliquely beneath the right iliac crest and beyond the left side of the spinous processes. Two others, with the broad portions below, placed just above these are then carried above the left and right iliac crests to fasten posteriorly, each being long enough to reach beyond the spine. Before this is done, it is advisable to place the patient absolutely at rest and completely relaxed, with the head low and the hips well elevated, then to lift the abdomen as much as possible, and finally to apply the retaining zinc oxide plaster. This binder may be kept on from two to four weeks; and after it is taken off, the skin should be bathed with turpentine to remove the old plaster, this being followed, in turn, by a soap and water cleansing bath and a final sponging with alcohol. If the skin is chafed, twenty-four hours should elapse before a bandage of similar construction is reapplied.

Advantages of knee-elbow position for correction of visceral ptosis emphasized. Case of recurring pain, nausea, etc., due to movable kidney in which as soon as the patient, a young woman, assumed the knee-elbow position she experienced relief. She learned to use this as a prophylactic measure, *e.g.*, before going out for a walk. The pains come on when the stomach content is being passed on into the intestine, the latter being compressed by the movable kidney. Fellenberg (*Correspondenzbl. f. Schweizer Aerzte*, March 1, 1911).

In the writer's 500 cases, primary or independent chronic excessive toxemia was met with in 50 per cent., secondary, or dependent upon the ptosis, in 24 per cent., and toxemia-

free 26 per cent. Therefore, 50 per cent. of all cases have one of the forms of primary chronic intestinal toxemia, and unless this is controlled recurrence of symptoms is very liable to happen in a few months' time. This requires dieting according to the toxemia present, high proteins for the saccharo-butyric, carbohydrate for the indolic, and carefully weighed diet, so there is no excess, in the mixed forms. Vaccines are essential to bring results about, these always being autogenous, and used in bold doses, the selection being according as the bacteriology of the gut is off from normal standards. At least 90 per cent. of these most difficult ptosis plus primary toxemia cases are curable by vaccines and diet.

A few cases are surgical. All distinct cases considered, the number requiring surgery represents about 1 per cent. When decided upon, a careful clean-up of angulations, adhesions, bands, as well as suturing the organs in higher position, are required. But even with these it is well to treat them medically for some time after operation. Anthony Bassler (*Med. Record*, Dec. 21, 1918).

After correcting constipation and dietetic errors, securing uninterrupted sleep each night, and at the same time urging the ingestion of food of high caloric value,—soups, broths, and liquids in any amount being avoided,—it will be found in the majority of instances that considerable improvement has been obtained. Abdominal massage and general massage, including some resistance movements, will considerably hasten improvement, but complete recovery is only possible either through deposition of fat or by the improvement of the lateral abdominal muscle group, which constitutes the natural support.

Following treatment recommended in cases of moderate abdominal ptosis: Three times a day, after



Physical exercises for enteroptosis. (W. Egbert Robertson.)



meals, the patient should lie down for half an hour on a flat, hard mattress without a pillow under the head, but with a small pillow between the shoulder-blades. At least once a day an exaggerated Trendelenburg position should be assumed by raising the foot of the bed or sofa. Shoulder-braces, massage, and light, graded exercise to improve the muscles, especially those of the back, abdomen, and shoulders, are also to be ordered and the patient should wear continuously, except when in bed, a proper abdominal support. Mumford (Boston Med. and Surg. Jour., Aug. 10, 1911).

Résumé of the rest-cure treatment of movable kidney and associated ptosis: *First to third day.* Rest in bed, with foot of bed elevated. Snug abdominal binder worn continuously. Chloral and bromide or other hypnotic to secure eight to twelve hours' sleep. Spring water every hour. Gentle friction over trunk; kneading abdomen once daily. As tonics, digitalis, strophanthus, and iron. Soap-suds enema and castor oil. *Fourth day.* Same except add fluid diet every two hours, and saline laxative in hot water, 6 A.M. daily. *Fifth day.* Same, except substitute passive motions for massage, and change tonic to tablets of iron, arsenic, quinine, and strychnine, 1 to 4 after each meal. Do whatever reparative operative procedure is necessary on cervix, perineum, tubes, ovaries, rectum, bladder, nose, and throat. Examine eyes; no reading until glasses are fitted, if necessary. *Seventh to twenty-eighth day.* Still in bed, and measured for corset. On *fourteenth day* begin semisolid nourishment every three hours. On *twenty-first day* begin active resisted movements, and cascara and hydragric as cathartic. *Twenty-fifth day.* Still in bed; mixed diet three times a day, liquid food between meals. *Calisthenics.* *Forty-second day.* Corset to be put on before getting out of bed. E. Gallant. (Lancet-Clinic, May 11, 1912).

For some years I have employed with more or less advantage a series of exercises, but whenever possible I have prevailed upon patients to join a good gymnasium, where in addition to deriving the benefit of the exercise itself they are subject to the unconscious influence of healthy stimulation and emulation. I am indebted to Dr. W. J. Schatz, formerly Director in the Department of Physical Education of Temple University, Philadelphia, for the following consideration of exercise treatment in visceroptosis: Physical exercises which make for permanent widening and deepening of the chest, for strengthening and shortening of the abdominal muscles, and for proper poise of the body bring about mechanical conditions which favor support for the abdominal organs. During the exercises little clothing should be worn: none that constricts the waist or limits any movement should be allowed. Pajamas and stockings or a gymnasium suit serve the purpose well. Exercises should be done in the morning before breakfast and in the evening before retiring, their number being increased as the general condition and strength of the patient warrant.

The exercises are shown in the annexed illustrations:—

Figure 1 shows the best position for the patient. Several blankets are placed on the floor so as to form a pad several inches higher at the hips than at the head. With the patient's knees flexed, the abdominal muscles relaxed, and gravity favors of the organs. The patient then places both hands on the abdomen, the ulnar borders being parallel with Poupart's ligaments and just above

them. After full expiration, the glottis should be closed and the movement of inspiration made by forcibly lifting the chest, thus forcing the entire abdominal contents upward toward the diaphragm. At the same time, the abdominal contents should be manually lifted, and the arms then rapidly raised over the head laterally, thus further increasing the expiratory effort. Relaxing, the patient now assumes the first position, takes several breaths, and then repeats the movement.

Figure 2 explains the next exercise. The patient, lying in the same position, elevates both legs, keeping the knees stiff and the toes pointed in extension. The exercise is repeated half a dozen times. This is at first difficult, and is followed by a certain amount of abdominal soreness, which soon subsides with continued exercise. Though strengthening the abdominal muscles, this exercise does not shorten them materially, as their action is mainly that of fixing the pelvis while the flexors of the thigh raise the leg.

Figure 3 shows the next position. During this exercise the legs should be kept constantly flexed upon the thighs. Beginning with the first position (Figure 1), except that the arms are employed to assist in elevating the hips, and with the legs flexed upon the thighs, the thighs are then forcibly flexed upon the pelvis. The last stage of this upward pull should be done rather forcibly. The position should be maintained for one-half minute, the patient then returning to the first position. The exercise is repeated several times.

In each of the exercises thus far described the pad may be lowered

as the patient's strength increases, until a horizontal position is reached. A pad, however, will always be necessary, in order to avoid bruising the tissues over the spine.

Figure 4 illustrates the exercise especially designed to strengthen the lateral muscle group. Starting with the position shown in the second figure, but with the arms extended obliquely outward and the legs kept extended upon the thighs, the patient allows them to drop first to one side, to the left, as shown in Figure 4, then again at right angles to the trunk, preparatory to dropping them to the right. This exercise should be continued alternately to the right and left until the muscles tire.

Figure 5 illustrates the "turnstile movement." In this the arms are carried alternately up and down, always extended, as shown in the figure.

It is of importance to preserve the lumbar curve, which the exercise shown in Figure 3 does not tend to do. It is probable that the anterior projection of the spinal column in the lumbar region acts somewhat like a shelf, more or less supporting the abdominal viscera above. Figure 6, accordingly, is designed to do this. The patient, lying prone, raises the upper and lower extremities of the body sufficiently to be able to imitate the movements of the breast stroke in swimming, as far as the arms are concerned. With the back arched, the knees slightly flexed, the arms are brought forward with a lateral swinging movement to a point as far front as possible. This is repeated several times.

The next exercise is designed to elevate the chest with a view to per-

manent lifting of the abdominal contents, at the same time increasing the capacity of the upper abdomen by broadening the waist. In Figure 7 the subject is shown seated on a chair, with knees separated and hands resting on the thighs, close to the body. The chest is then elevated as high as possible, held in that position a few moments, then allowed to sink by relaxation. No attention need be paid to the breathing while performing this movement, as it is not intended as a breathing exercise. It is intended to raise the chest upward and forward as far as possible, thus developing the muscles concerned in this act and stretching the structures which oppose elevation of the chest.

Figure 8 shows a general exercise the object of which is to improve the general body tone, the muscles of the legs and thigh especially, and, further, to increase the tonicity of the cardiovascular apparatus. The abdomen should be drawn in throughout the exercise, the patient alternately rising to the erect posture and then assuming the position shown in the figure.

Cases of ptosis due to a congenital habitus are not relieved by operation, except rarely. In cases following childbirth resection of the relaxed ventral tissue through the method suggested by Webster may give perfect relief provided the diastasis has not been of such long standing that the abdominal organs are far below their normal levels. In the latter case, in addition to the Webster operation, it may be necessary to suspend the colon by means of the omentum, thus relieving the stomach of the weight of this organ, and at least temporarily supporting the stomach until there may be a natural shortening of its ligaments. In a simple gastropptosis without marked participation of the colon

the *Beyea operation* may be the one of preference.

In exaggerated cases of ptosis of the transverse colon, with fecal stasis and a tendency to twisting, causing symptoms of partial obstruction, nothing less than **excision of the redundant loop with end-to-end anastomosis** will cure. In redundant sigmoid, with more or less constant pain in the left side, and obstinate constipation, **suspension of the sigmoid** may give entire relief, though, on account of the constant mobility of the sigmoid, a recurrence may be noted. In exaggerated cases of redundant sigmoid, with extreme constipation verging on to obstruction, **resection of the sigmoid** may be advisable. In all cases a carefully fitted **abdominal support** or corset should be worn after operation. J. G. Clark (Surg., Gynec. and Obstet., April, 1908).

In prolapse of the cecum symptoms resembling appendicitis with constipation are sometimes present. In addition to **appendectomy**, the **caput coli** should be anchored in its normal position as follows: The reflection of the parietal peritoneum on to the mesocolon is nicked with scissors and the incision extended downward parallel with the cecum as far as the brim of the true pelvis and upward for 4 or 5 inches. The peritoneum is stripped away from the mesocolon and from the posterolateral wall of the false pelvis. Into the pocket of peritoneum thus formed in the right iliac fossa at the normal site of the caput coli the caput is placed and there secured by catgut, sewing the edge of the peritoneal flap to the middle white line of the caput. The lowest suture is placed about 1 inch above the site of the base of the appendix. Two other sutures are placed above at intervals of 1 inch. Thus the caput is securely fastened in a large pocket, the lining of which must rapidly become adherent to the intestinal peritoneum. R. S. Fowler (N. Y. State Jour. of Med., July, 1911).



for 3 years and gained in every way since the removal of a chronically ulcerated appendix with concretions and the breaking up of adhesions around the cecum. When a case has become progressively worse under medical treatment, surgical procedures directed to the intestinal tract are indicated. Many chronic eye lesions cannot otherwise be cured. H. M. Thompson (Jour. Ophthal. and Oto-Laryn., xi, 343, 1917).

**DIAGNOSIS.**—Beside the foregoing phenomena many of which may be discerned in all cases, the location of coprostasis must be determined. As previously stated, the seat of retention, if within reach of the palpating fingers, is often sensitive under pressure, while it may also be the seat of accumulated flatus movable under pressure with perhaps a history localized, at times painful or "colicky" borborygmi. According to Sir Arbuthnot Lane and his school, kinks of the intestine, adhesions and bands formed especially in the neighborhood of the ileocecal valve, the gall-bladder and the sigmoid flexure of the colon, may produce stasis mechanically.

Keith has urged that other areas are subject to stasis owing to spasm of certain muscular elements concerned with peristaltic contractions. He holds that the outer longitudinal and inner circular layer of involuntary muscle fibers are innervated by a sympathetic paraganglionic plexus lying between them, the myenteric or Auerbach's plexus, corresponding in structure to the cardiac atrio-ventricular bundle and that its function is to act as pace-maker for the peristaltic contractions. Aggregates of this plexus—whose structure is intermediate between nerve and muscle—form nodes in certain regions: the cardiac

orifice of the stomach, the entrance of the common bile duct, the duodenal-jejunal angle, the ileocecal junction, the point of union of the proximal (the cecum and ascending colon) and transverse colon, and finally the descending colon. Of these the ileocecal junction is that most likely, owing to its sphincter-like structure, to offer spasmodic mechanical obstruction to the fecal contents. While Keith states that X-rays have failed to indicate obstruction at bands and kinks, as held by Lane, the evidence is fairly complete that derangement of the musculature of the ascending, transverse and descending colon exists, characterized by marked increase in the tonus of the segments, sufficient in some instances to induce spastic contraction and obstruction.

According to Kellogg, the cause of ileal stasis lies in an incompetency of the ileocecal valve, due to some obstruction in the colon, usually adhesions of the pelvic or iliac colon.

Stress laid on relationship of foci of infection in the upper respiratory and digestive tracts to those in the lower digestive tract. A complex fecal flora is almost always associated with dental, tonsillar, respiratory, or gall-bladder infection. Intestinal putrefaction so alters the protective secretions as to allow infection from above to gain lodgment. Intestinal toxemia may be (1) putrefactive, comprising indolic types with or without indicanuria, and butyric types with *B. aerogenes capsulatus* infection, or (2) pyogenic. Norman and Eggston (N. Y. Med. Jour., Dec. 6, 1922).

The symptom-complex of chronic intestinal stasis and toxemia cannot be explained alone by a mere mechanical alteration of motility. There are also to be considered bacterial invasion; disturbances of innervation of the bowel and of the endocrin system; production of pathologic lesions in the bowel;

changes in the intestinal secretions, and food decomposition forming toxic products. Which factor plays the chief rôle is as yet unknown. Friedenwald (*So. Med. Jour.*, Apr., 1924).

Recognition of a condition of stasis anywhere in the gastrointestinal tract is best accomplished by giving a barium sulphate meal—2 to 3 ounces (62 to 93 Gm.) in a pint of buttermilk—and observing its progress fluoroscopically and röntgenographically in its passage from the mouth to the anus. Additional information is also obtained by examining similarly after the use of a barium sulphate enema after cleansing out the colon an hour before the examination. The oral use of barium does not require preliminary preparation, the patients being allowed to follow their usual habits, even to the taking of their habitual laxative, if such be their custom. This avoids disturbing the conditions to which the symptoms and their causes are due. When gallstone is suspected, however, a purgative should precede the examination, to avoid confusing and misleading shadows in the colon.

The main points to be noted are the duration of the passage of the barium meal, minutes, hours, etc., to reach fixed landmarks, such as the ileocecal juncture, the cecum proper, the ascending transverse and descending colon to the anus. It should have passed completely at the end of 30 hours. If this period is prolonged, the seat of retention should be sought, watching out also for kinks, bands, adhesions, fixations, etc., capable of strangulating the intestine, as shown by the shape of the latter; and also for modifications of outline, the transverse colon particularly, which may

be elongated and assume the shape of a hammock or even of a U and the descending colon, which may take on almost any kind of shape,—a complete coil as in one of my own cases—and offering ample opportunity for retention. In keeping with Keith's researches, referred to above, delay in the progress of the barium meal may be noted at the cardiac and pyloric orifices of the stomach and the duodeno-jejunal junction. Where anti-peristalsis is most active in the transverse colon, about its anterior third, a constriction ring has been described by Cannon, which may be the seat of obstructive constriction. This anti-peristalsis may in fact keep the cecum filled several days and prove a source of active intoxication.

Four examinations are usually made under the fluoroscopic screen, at intervals of 6, 8, 20 and 30 hours. At the end of the sixth hour the barium has passed entirely out of the stomach and is generally found in the cecum and ascending colon with a remnant in the terminal ileum. About the ninth hour it reaches the splenic flexure of the colon and enters the rectum about the end of the twenty-fourth hour.

A careful Röntgen study furnishes the most valuable evidence as to the actual pathological conditions present in the gastro-intestinal tract, associated with intestinal stasis. The most constant factors are rectal retention and secondarily retention in the pelvic colon with elongation of the pelvic colon and transverse colon, dilatation of the ascending colon, atony, and incompetency of the ileocecal valves, resulting in regurgitation into the ileum, and absorption of the contents. A spastic condition of the bowels is present in the majority of instances, and this is aggravated

by irritative laxatives, to which class most laxatives belong. The spasticity may be caused by appendiceal or gall-bladder disease. G. E. Pfahler (Med. and Surg., July, 1917).

Cecal stasis may result either from marked enteroptosis with low grade inflammation or from chronic appendicitis. Fecal retention and regular bowel action frequently coexist, the retained feces being channelled or grooved by the more recent material. The functional condition of the organ, as revealed by the X-rays after an opaque meal, is of greater importance than its position. A chronic general intoxication is likely to result from cecal stasis, as the bowel content is here more liquid and favorable for bacterial growth than lower down. From toxic absorption may result persistent malaise; loss of weight, malodorous breath, headache, dizziness, and neurasthenic symptoms.

Eventually, febrile reactions, and sometimes pericolitis, cholecystitis, or colon bacillus infection of the urinary tract, may supervene. Baetjer and Friedenwald (Amer. Jour. Med. Sci., Nov., 1920).

The view that food residues are evacuated within 24 to 48 hours is largely erroneous, according to tests with 2-mm. glass beads, 50 being given in a gelatin capsule. The usual large amount of barium speeds up progress. Of the beads, 15 per cent were passed on the first day, 40 on the second, 15 on the third and 10 on the fourth; after that days or weeks might be required for the last few beads. The rate of progress varies widely in normal people. Some took a week or more to pass 70 per cent., yet had no symptoms. Alvarez and Freedlander (Jour. Amer. Med. Assoc., Aug. 23, 1924).

Examination of the rectum and sigmoid flexure by means of the proctosigmoidoscope affords considerable assistance, a large proportion of disturbances being located in the area within its reach, ulceration, growths,

contractures and spasms being readily discerned.

The main conditions with which intestinal stasis may be confused are chronic appendicitis, salpingitis, angiocholitis, enteritis, latent tuberculosis and neurasthenia. Diarrhea is not an indication of the absence of stasis; in fact, some severe cases of stasis are accompanied by this symptom, which probably represents an effort of Nature to facilitate the elimination of toxic materials by liquefying them.

**TREATMENT.**—Sir Arbuthnot Lane is generally thought to advocate colectomy in intestinal stasis; but his true attitude is that 90 per cent. of these cases should be treated medically. When it is shown by the Röntgenogram that, as is often the case, the stasis is regional through localized enteroptoses, he recommends a **Curtis belt** and **liquid paraffin** as a lubricant to facilitate the passage of the intestinal content. This is especially indicated when there is angulation of the bowel at various points at which it is fixed. Careful **dieting**, including abstention from meats where spasm underlies the condition, antacids, such as **sodium bicarbonate** or **magnesium oxide**, where hyperacidity exists, and the **recumbent posture** at stated intervals during the day, have been found by him often to afford complete relief.

An important feature in my own cases, excepting those due to spasm, in which oil should be used (*vide infra*), is the use of **high positional irrigation**—not the obsolete “high enema”, since the insertion of a tube high up in the rectum, etc., has been shown by our Associate Editors, Pro-

fessors Brooker Mills and Bird, to be based on the fallacious idea that it will follow the course of the intestine, whereas in reality it coils within the rectum assuming the shape of a pretzel if enough of the tube is inserted—but by positional direction of the fluid used. Thus 2 pints (1000 c.c.) of water at 105°F. are injected while the patient is in the knee chest position; after remaining in the same attitude 5 minutes, he then gets on his right side thus causing the fluid to pass from the transverse colon to the ascending colon and the cecum. The patient remains in this position about 20 minutes. This tends not only to straighten out any flexure, kink, etc., that may favor stagnation in the bowel, but also to liquefy and detach any fecal matter in the areas that are the seat of stasis. The use of X-ray examination, by determining the location and nature of these areas, makes it possible to adjust the positions to the needs of each case. The elimination of the fluid is often accompanied by considerable retained matter. **Cold enemata** are advocated by some. Large daily enemata of any kind are to be condemned: they cause, in fact, intestinal stasis in some cases by promoting parietic dilatation of the colon.

While the **Curtis belt** tends to remedy the enteroptosis which often accompanies intestinal stasis, particularly where insufficiency or relaxation of the abdominal muscles occurs in the aged, the obese, or the physically inactive, or follows frequent pregnancies, faulty posture, etc., **physical exercise** to enhance metabolic activity, out-of-door games, etc., **massage** of the abdominal walls, carefully regulated gymnastics, and

**external hydrotherapy** help greatly the curative process itself, particularly if the patient acquires the habit of attending to his toilet duties at a fixed time each day. Cathartic drugs should be avoided. Deficient sigmoid or rectal contractility is often aided by an enema, 4 ounces (120 c.c.) of **warm olive oil** or **liquid petrolatum** retained over night, the patient wearing a pad.

**Fleiner's oil cure**, which consists of injecting into the rectum 250 to 500 c.c. ( $\frac{1}{2}$  to 1 pint) of olive oil is advocated. Pure cottonseed oil yields equal benefit. The oil should be retained over-night, if possible. The injections are continued several months, at first daily, later every other day, and finally twice a week. They are useful both in spastic and atonic constipation. Poorly nourished patients should be well fed, by **forced feeding** if necessary. **Cold water, half baths**, and the **Scotch douche** on the abdomen, with **rubbing and slapping**, are valuable; likewise **respiratory gymnastics** several times a day and **dry rubbing** of the skin with rough towels. **Massage** will strengthen the abdominal muscles, and **bandaging** the abdomen acts beneficially. All the patients need **iron**, but the sovereign remedy is **atropine** or **belladonna**. C. D. Aaron (Buffalo Med. Jour., Aug., 1916).

Where the condition is not advanced, following measures endorsed: Meats to be reduced to a minimum, **butter-milk** or **sour milk** being largely substituted; an occasional **aperient**, if necessary; **liquid paraffin**, 2 tablespoonfuls twice a day  $\frac{1}{2}$  hour before meals; **rest on a bed with its foot raised**. Abdominal massage, respiratory and other exercises, intestinal vaccines, **organotherapy**, **electric treatment**, **ionization**, colon lavage, eradication of any secondary infection, such as pyorrhea, and **intestinal antiseptics**, are all important. Of the antiseptics, Ainslie Walker's **dimol** proved beneficial in

many cases. Sir W. Arbuthnot Lane (Pract., May, 1922).

Three lines of attack advocated: (1) Making good endocrin insufficiency, which may be the cause, with **thyroid**, **suprarenal**, or other gland extracts; (2) discouragement of intestinal flora by **ichthyol** (2½ grains 2 or 3 times a day), **phenyl salicylate**, or **benzonaphthol** (preferable to betanaphthol), together with **purgatives** and **enemas**; (3) **injection** of various forms of **protein**, *e.g.*, Danyasz's heterogeneous bacillary proteins, subcutaneously, or **peptone**, intravenously. F. J. Sadler (Lancet, May 13, 1922).

The patient should be fed on a **lactose-laden diet** and given **B. acidophilus** by mouth and **rectal implants** of **B. acidophilus** and lactose. Satterlee (N. Y. Med. Jour., Dec. 6, 1922).

Following measures reliable where X-ray has excluded surgical conditions: A **Curtis belt** for ptosis; **liquid paraffin** for colonic stasis; **belladonna** for spasm of sphincters; **colloidal kaolin**, 1 dessertspoonful in ½ tumbler of hot water night and morning, to absorb the intestinal toxins, and a **saline purgative** to drive onward contents of lower ileum. **Autogenous vaccines** are of considerable importance in many cases. A. C. Jordan (Lancet, Mar. 3, 1923).

To prevent chronic stasis, the diet should consist as much as possible of **vegetable food** consumed largely in a raw state to avoid damage to vitamins, the unassimilated part serving to increase bulk. Free use of **liquid petrolatum** is essential. All operative measures should begin by an examination of the last kink and careful freeing of the bowel from its acquired attachment to the iliac fossa. Arbuthnot Lane (Brit. Med. Jour., Jan. 26, 1924).

When none of these measures succeed, surgery may be resorted to. Each case must then be studied individually, the location and character of the ptosis being ascertained radiographically as far as possible before the operation to facilitate its identi-

fication when the abdomen has been opened. The operation should restore the physiological action of the bowel and its complete emptying, relieve back pressure and reflux into the ileum, avoiding any tissue destruction that may compromise its functions.

An appendix the seat of chronic adhesions, causing obstruction at the terminal ileum, or a band at the base of the gall-bladder, causing a twisting at its outlet and retarding the flow of bile into the common duct; are relieved by simple operations. Removal of viscera is unnecessary except in rare cases. J. G. Young (Ill. Med. Jour., Mar., 1922).

Case of typical Raynaud's disease with constipation, pain and flatulence. X-ray showed dropped colon, kink of iliac colon, cecal distention, catarrhal colon and appendix, ileal kink, duodenal distention and pyloric spasm. Three months after operation to free the iliac colon and remove the appendix the last suspicion of Raynaud's disease had disappeared. A. C. Jordan (Med. Jour. and Rec., Sept. 16, 1925).

While formerly such radical operations as excision of the cecum or resection of the transverse colon, the sigmoid, colectomy, and short circuiting operations were advocated, the tendency has been increasingly to use simpler operations.

Many cases of stasis are found to be due to peritoneal bands and omental adhesions, and the removal or section of these often cures the patient. Ileosigmoidostomy and total colectomy should be abandoned. On the other hand, **cecosigmoidostomy** may be employed in certain obstinate cases with good results in %. Yeomans (N. Y. State Jour. of Med., Sept., 1918).

Operative interference is indicated in cases in which gastroduodenal distension is due to a damming back of the ileal contents by the pressure exerted by a "controlling appendix" or by an "ileal kink." The degree of in-

interference can be determined by the appearance of the patient, the history of the case, the pain elicited on pressure on the inflamed and hypertrophied end of the ileum, and the X-ray findings. Removal of the anchored appendix or the freeing of the ileal kink is usually sufficient to liberate the duodeno-jejunal junction from the strain. It is well to remember that the membrane which produces the ileal kink when well developed appears to contain lymphatics which drain the most infected portion of the ileum. Therefore, after the acquired band has been carefully separated from the mesentery and the torn peritoneal edges placed in accurate apposition, a drainage tube should be left in for two or three days, a precaution which may save the patient's life. It must be remembered that the kink tends to reform if the factors which produce it remain in action. **Colectomy** is indicated in such conditions as extreme constipation in which an evacuation can be obtained only at intervals and with great difficulty and pain; rapid and progressive wasting; mental depression which may result in attempted suicide; total inability to lead an active life; distressing absence of sexual desire; progressive degenerative changes in the breasts of those with marked family history of cancer; toxic changes in the heart and circulation, and all secondary conditions such as rheumatoid arthritis, Raynaud's disease, Still's disease, many forms of tubercle, Bright's disease, Addison's disease. In these and many other conditions, colectomy offers the only hope of cure. The writer points out that by colectomy, he means the *complete* removal of the large bowel with exception of a sufficient length of the pelvic colon to establish continuity. Removal of the cecum, ascending and part of the transverse colon, is rarely useful. Sir W. Arbuthnot Lane (Lancet, Mar. 1, 1919).

Marked thirst is usually complained of some time after the operation,

particularly after removal of any part of the colon, owing to reduction of the absorption surface. This symptom gradually disappears, however, the remaining structures assuming the functions of the segment removed.

### HIRSCHSPRUNG'S DISEASE OR CONGENITAL MEGACOLON.

**DEFINITION.**—This is a congenital form of intestinal stasis in which a part or rarely the whole of the colon is markedly dilated, generally with hypertrophy of the bowel wall and elongation of the gut affected.

**SYMPTOMS.**—Constipation is noticed, as a rule, in early infancy, even the meconium being passed only with difficulty. Fecal tumors, palpable through the abdominal wall or by rectum, soon form, and are not removable by cathartics. Later the accumulations may be such as to cause marked distention of the abdomen, and visible peristalsis may be observed. Bowel movements may occur only at long intervals. In older children a valvular fold of the mucus membrane may be found upon rectal examination. Where the thoracic viscera are pressed upward by the fecal mass, the respiration may be purely costal and the heart action enfeebled; reabsorption of toxic material may also take part in the latter effect. Emaciation is a natural accompaniment, and apathy, unconsciousness, twitchings, tetany, and convulsions may be met with as toxic nervous symptoms.

Disturbance of the kidneys may occur from pressure on the ureters, and the superficial veins of the abdomen may be found dilated, and the legs edematous. Vomiting and pain

are only occasional symptoms. Exertion, straining, vomiting, or operative intervention may cause sudden death from collapse, owing to the weakened condition of the heart, or death may occur from septic colitis or bowel perforation and peritonitis.

Case of Hirschsprung's disease in a girl, aged 6 years, brought to the hospital in a condition of shock. She had been constipated for 5 years and had vomited for 24 hours. The patient was cyanosed, the eyes staring, the temperature 97.5° F. and the pulse 120. The abdomen was distended, and there was a constant involuntary discharge of feces. The thirst was intense. Colonic irrigations of physiologic sodium chloride solution were given with stimulation, heat, etc. The blood was viscid and not absorbed by Tallqvist paper. The child died 11 hours after admission. Secondary calcification of the lower part of the sigmoid and the upper part of the rectum were found. W. L. Carr (Trans. Amer. Pediat. Soc.; Jour. Amer. Med. Assoc., July 27, 1918).

**DIAGNOSIS.**—This is based upon the symptomatology of the disorder and an X-ray examination.

**PATHOLOGY.**—Usually the sigmoid is chiefly or exclusively involved; its circumference may attain 50 to 70 centimeters. At times enlargement of other segments, *e.g.*, the cecum and transverse colon, coexists, with the intervening segments quite normal. In the thickening of the bowel wall, the circular muscle layer is more hypertrophied than the longitudinal. Externally the affected gut presents a smooth appearance, the sacculations, *teniæ coli*, and sometimes the epiploic appendages having disappeared. Kinking of the bowel, commonly at the junction of the sigmoid and rectum, is believed

to occur as a secondary change in a majority of the cases, the result being a valve-like fold which accentuates the obstruction and its symptoms.

A valve formation in the bowel is the primary factor in certain cases of megacolon. The writer deems the term megacolon congenitum a misnomer. In a case developing at the age of 44, cured by sigmoid resection, there was a valve-like formation, but the flexure probably had been naturally large, and prolonged constipation had stretched it. Such cases are not true Hirschsprung's disease. R. J. de Jong (Neder. Tijds. v. Geneeskunde, May 20, 1916).

At times obstructions are alleviated by nature, by diet, and by enemata, or they may go on to obstruction, be operated on and pass away. The prognosis is very bad if one makes an artificial anus. Some cases with this condition proceed to adolescence. It may be rapidly fatal or go along quite normally for a time. Henry Koplik (Trans. Amer. Pediat. Soc.; Med. Rec., Dec. 14, 1918).

The name Hirschsprung's disease is applied to a stage in a common condition. When this condition is dignified by the term, it is in a late stage of the disease. The time to treat it is before the dilatation occurs. There are many cases of Hirschsprung's disease walking about today, some will reach the stage of dilatation when they will be recognized and others will not. F. B. Talbot (Trans. Amer. Pediat. Soc.; Med. Rec., Dec. 14, 1918).

The writer has reported 20 cases of elongated sigmoid. These cases are fairly usual and the name Hirschsprung's disease should be dropped. They are identical with the elongated sigmoids that fold upon themselves and become sacculated and dilated and are accompanied by sacculations and later constriction. The condition is one that is very frequent and it is the severe cases that go on to the formation of gross lesions. C. G.

Kerley (Trans. Amer. Pediat. Soc.; Med. Rec., Dec. 14, 1918).

Case added to those on record in which intestinal obstruction from muscular spasm was the cause. It occurred 14 cm. above the anal sphincter, a button being found above the contraction ring. Localized functional spasms may also act as cause. Behring and Klercker (Acta Pæd., Oct. 25, 1924).

An increasing number of adult cases of megacolon are being reported. Dowd found it impossible to differentiate in the literature the cases due to a congenital defect from those due to mechanical or spasmodic obstruction. As noted by Finney, none of the etiologic theories explains all cases, and in a goodly number of actual cases, no satisfactory explanation has been found.

Francioni's method, which consists in introducing a long, flexible tube into the rectum to overcome the effects of a kink held responsible for obstruction, used with benefit in 2 cases. The tube is left in place for a number of hours, up to 36, and reintroduced at intervals of 4 or 5 days or oftener as symptoms develop. In each case the tube seemed to meet with an obstacle past which it had to be worked. A cure seemed to result in an infant; in an older child, the treatment was continued at intervals for several months. Magliani (Riv. di clin. ped., June, 1920).

**TREATMENT.**—Non-operative treatment, alone appropriate in early infancy, consists in evacuating the bowel as well as practicable with **enemas**, and in continuing nursing as long as circumstances permit. Permanent drainage of the rectum by a **rectal tube** has been advised. Operative treatment is alone satisfactory. In greatly weakened subjects, preliminary institution of an **artificial anus** is frequently advisable to per-

mit of unloading the bowel and improving the general condition. **Re-section** of the affected portion of bowel is the best operative procedure. Any **kink** below the enlargement must likewise be **eliminated**.

Of 151 cases treated by internal measures alone, only 38 were cured and 14 improved; 79 died, and the outcome was unknown in 14 cases. **Sedatives** should be used for spasm in any part of the bowel. The **sphincter** in spasm should be bloodlessly stretched. **Massage**, **electricity**, and **diet**, with **bowel irrigations**, will often cure early cases. Schneiderhöhn (Zeit. f. Kind., xii, Nu. 4-5, 1915).

Stress is laid by the writer on a group of cases which have recurring attacks of pain, fever, vomiting, and acute obstructive signs, despite every effort to prevent them. In other cases, constipation will often yield to careful treatment, especially **saline enemata**. **Massage** helps the abdominal wall, and mechanically moves along fecal material, especially with a drainage tube in the rectum. The **diet** should consist of coarse breads and cereals, green vegetables, and agar-agar. **Much water** should be taken. **Russian oil** is very helpful. Smith (Lancet-Clinic, Mar. 23, 1916).

In a case that developed Hirschsprung's disease after the age of 3, the writers gave each morning, on an empty stomach, **sodium sulphate**, 0.5 Gm. (7½ grains); **sodium bicarbonate**, 0.3 Gm. (5 grains), and **sodium phosphate**, 0.2 Gm. (3 grains). **Moist heat** to the abdomen and **oil enemas** were also used. In 2 weeks the abdominal circumference was reduced from 62 to 48 centimeters. Improvement continued. Hallez and Blechmann (Arch. de méd. des enf., Aug., 1921).

Analyzing 118 cases, including 5 of his own, the author found 60 treated medically, with 41 deaths and 7 cures, and 58 surgically, with 24 deaths and 24 cures. Lass (Boston Med. and Surg. Jour., Jan. 27, 1921).

The mortality in late years has been 48 to 27 per cent., which is much less



than formerly. The mortality rate for semipalliative operations, such as **colostomy** or **appendicostomy**, is 7 per cent. higher than that for the other group of resections combined, and their curative percentage is small. A **partial colectomy** is the operation of choice, and can be done either in a single operation with **intra-abdominal anastomosis**, as a two-stage operation with a **short-circuit operation** or a **preliminary colostomy** as the first stage, or as an **extra-abdominal resection** in 2 or more stages (method of Mikulicz). The mortality and dangers diminish in the order given, shock and sepsis being minimized in the third of these procedures. Dowd (*Ann. of Surg.*, Oct., 1921).

Case in a boy of 10 years in whom the whole large intestine was involved, and the entire colon was removed. The lower ileum was united with the upper rectum. The result was excellent, no harmful sequels occurring. During 15 months elapsed after operation the boy developed normally. E. Huber (*Deut. Zeit. f. Chir.*, Mar., 1924).

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## INTRAVENOUS THERAPY.

—The introduction of arsphenamin for the treatment of syphilis was followed by a marked awakening of interest in the intravenous method of administering drugs, previously regarded as being attended with such risks as to preclude its use except for certain emergencies.

The intravenous mode of introduction is characterized, in general, by great rapidity of action, absence of the stage of absorption into the blood stream from the gastrointestinal tract or other tissues (the drug having been introduced directly into the blood), and complete utilization of the amount injected in the therapeutic action, there being no opportunity for non-absorption of a portion of the dose or its decomposition in the tissues before it reaches the blood-stream. The action of a drug injected intravenously thus reaches its acme in a much shorter time than after other modes of introduction, and this acme attains a higher level, *i.e.*,

a greater intensity of action is attained, because the entire amount administered begins to act at once. On the other hand, there is a tendency to shortened duration of action owing to the fact that the entire amount of the drug becomes at once subject to the processes of elimination and decomposition, whereas with other routes the drug is subjected to these influences only gradually, in proportion as it is absorbed. In the case of metallic drugs, the arsenicals, digitalis, bromides, and other drugs showing a tendency to storage in the tissues or cumulation, the brevity of action is mitigated by the fact that the drug is held for a time in the structures to which it is distributed by the blood and becomes so combined or otherwise held that its elimination or destruction is gradual instead of abrupt.

**RISKS OF INTRAVENOUS INJECTION.**—Considerable stress has been laid upon the danger attending the introduction of air into the patient's vein. Small amounts of air may cause no ill-effect or may result in dyspnea, cyanosis and weak pulse. According to some observers, trouble from this source is rare and is scarcely to be feared. Yet there can be no question that large amounts of air may be productive of very serious results. The chances of the accident are reduced to a minimum by care and suitable technique. Upon injection with a needle directly puncturing a vein and the fluid entering from a closed syringe filled with it, the risks are obviously less than where an opening has been cut into the vein with scissors and the fluid introduced from an open receptacle.

The risk of acute dilatation of the heart is dependent upon either an excessive rate of administration or an excessive total amount of fluid, and is minimized by avoidance of error in these directions and by watchfulness of the condition of the patient's circulation during the injection. In this connection it should be borne in mind that even a stimulant drug, injected intravenously without excess of bulk, may, when introduced abruptly, cause a depression of heart-action and drop in blood-pressure, generally temporary, but possibly of serious effect in certain cases.

The risk of infection is practically eliminated by proper aseptic technique and avoidance of a preliminary skin incision.

The most serious source of danger, it would seem, is that relating to possible changes in the blood or organic functions induced by drugs the actions of which, when thus administered, are incompletely known or which are injected in excessive concentration. It is this risk, in particular, which attends the indiscriminate use of any and all drugs intravenously before adequate studies of the effects of each have been made. Hanzlik, DeEds and Tainter (*Arch. of Int. Med.*, Oct., 1925), in dogs, observed important changes in the blood, usually with disturbance of physiologic functions, from small or large doses of 10 per cent. sodium chloride solution, 85 per cent. sucrose, 50 per cent. dextrose, 0.1 per cent. agar, 6 per cent. acacia, 5 per cent. gelatin, 5 per cent. copper sulphate, 9 per cent. calcium chloride, 21.7 per cent. sodium iodide, 50 per cent. sodium salicylate, 0.33 per cent. arsphenamin and 5 per cent. peptone. Darkening of the blood, with increased sedimentation rate, agglutination and hemolysis followed the injection of agar, acacia, gelatin, copper sulphate, sodium iodide, sodium salicylate and arsphenamin, with the exception that there was no hemolysis with the iodide or salicylate. Darkening and agglutination took place with dextrose, hemolysis with 10 or 0.1 per cent. sodium chloride solution, and increased sedimentation with 10 per cent. sodium chloride. Changes in sedimentation also occurred with calcium chloride and sodium bicarbonate. These phenomena indicate surface changes in and injury to the blood corpuscles. Functional disturbances were evidenced by changes in the blood-pressure, pulse and respiratory rates, moderate to profound in extent and frequently resulting in collapse and sometimes in death. These observations plainly indicate a risk of possible harm when certain concentrations are approached, even if the dosage is relatively small.

**TECHNIQUE.**—Except where large quantities of solution are to be given, the gravity method of injection has been largely discarded in favor of the syringe. Cosmetic reasons and the avoidance of infection militate, moreover, in favor of direct insertion of a needle into the vein through the skin, instead of the preliminary incision, with or without the tying in of a cannula.

Generally convenient is a 10 c.c. all-glass or glass and metal syringe, of simple construction and adapted for easy and complete sterilization. For small, delicate veins a steel hypodermic needle, 22 or 24 gauge, is serviceable; its shank should preferably not be over  $\frac{1}{2}$  inch long (to facilitate the return of blood which proves that the vessel has been entered). For ordinary veins and frequent use, a  $1\frac{1}{2}$  inch tempered gold needle, of 20 gauge, is more durable (because of absence of the tendency to corrosion) than the steel needle, and avoids the possible staining of the skin from corroded steel. The bevel of the needle should be of medium length only, as a long bevel is difficult to manage in the vein. Phenol and alcohol may be used for sterilization of the needles. The more usual procedure, however, is to sterilize them by boiling along with the syringe.

The vein selected for injection is frequently the median basilic (see illustration, p. 679), although the smaller median cephalic has the advantage of avoiding close proximity to the brachial artery. Other veins, such as the femoral or external jugular (see p. 680) are sometimes used instead, and in infants, the superior longitudinal sinus is more easily entered than the other venous channels.

The patient should take no food for 5 hours before the injection, which is given with the patient recumbent and preferably undressed. At the area of injection the skin may be cleansed either with soap and water followed by alcohol or with tincture of iodine, which is then largely removed with alcohol.

Distention of the veins of the forearm is obtained by stroking the member down toward the hand and applying a constricting band above the elbow, such as an Esmarch or other rubber bandage, a soft rubber catheter, a gauze bandage, or the cuff of a sphygmomanometer or other similar device, inflated to a point insufficient to occlude the brachial artery. Bandages should be applied flat all around, to reduce discomfort, and the constricting band is best tied in a bow knot, for rapid and convenient release when the pressure is to be taken off. Vein distention may be enhanced by having the patient clench the fist tightly, by inclination of the limb, by hot applications, or, where

there is unusual difficulty because of adipose tissue, by applying an Esmarch bandage as for amputation, beginning at the wrist and travelling up to within a short distance of the selected vein.

In introducing the needle, the latter is held directly over and almost parallel with the vein, preferably with the index finger steadying the needle, and with the bevel directed upward. With the other fingers steadied by contact with the forearm, and the vein and neighboring tissues steadied and made tense by 2 fingers of the left hand, the needle is passed through the skin and vein, lifting slightly, until an abrupt lessening of resistance shows that the vessel has been entered. The needle is now almost horizontal over the vein. The plunger being drawn back slightly, blood will enter the fluid in the syringe, proving that the needle is in the lumen. The arm band is then loosened, and the fluid injected at a rate usually not to exceed 1 c.c. per minute.

Upon withdrawal of the needle, the puncture may be pressed upon with sterile gauze, a little tincture of iodine applied, or collodion employed to seal the opening.

**PREPARATION OF DRUGS AND INDICATIONS.**—The water used in preparing solutions for intravenous injection should be distilled as well as boiled, in order to eliminate any foreign—especially protein—material it may contain. The water should also preferably contain—particularly if the amount of solution to be injected is considerable—sufficient sodium chloride to make it isotonic with the blood. A wide variety of drug solutions are commercially available in sealed ampules, from which they can be conveniently aspirated—after wiping of the ampule with alcohol and breaking of its hollow stem—with the already sterilized needle and syringe.

The indications for intravenous treatment are mainly those based on the peculiarities of intravenous action alluded to in the second paragraph of this article. Immediate effects and the attainment of the highest possible concentration of the drug in the blood-stream are the chief criteria of the usefulness of this mode of therapy, which is therefore especially calculated for the quick relief of severe symptoms or prompt protection from seriously threatening bacterial or other invasions. Allega-

tions that because a given drug acts satisfactorily by mouth in a certain disease, it will necessarily act still better (aside from rapidity of action) when administered intravenously should be received with skepticism until definite proof of this (with control cases) is forthcoming. Among the few drugs in respect of which such superiority of the intravenous method (aside from the advantages of rapidity of action and of high concentration in the blood) has been demonstrated by adequate test, arsphenamin may be mentioned.

For the dosage and preparations of the individual drugs available for intravenous medication the reader is referred to the separate articles on the drugs. S.

**INTUBATION OF THE LARYNX.**—Medical science is indebted to Bouchut, of Paris, for the idea of relieving stenosis of the larynx by means of a tube introduced by way of the mouth; but to the late Joseph O'Dwyer, of New York, belongs the honor of reviving the operation from buried forgetfulness, and by his ingenuity of so modifying the instruments as to make them practical.

The relief of laryngeal stenosis by means of catheters introduced into the trachea through the larynx, the use of the short round tube as employed by Bouchut (Fig. 1), and O'Dwyer's early experiments and the gradual development of the instruments (Figs. 2, 3, 4, 5, 6, and 7) are all matters of history, fully recorded in literature.

Intubation of the larynx is a difficult operation. It requires maximum dexterity if it is to be performed with gentleness and celerity. One cannot become expert without considerable practical experience. We would emphasize the necessity of a thorough and careful training by practice upon the cadaver. Unless the operation is quickly and skillfully done, it becomes repulsive and brutal.

**INDICATIONS.**—Are all cases of alarming dyspnea to be treated by intubation? Most decidedly not. In case of foreign bodies so imbedded in the larynx as to produce difficult respiration the performance of intubation would obviously be a fatal mistake. Cases of pharyngeal abscess located low down, causing more or less difficulty in breathing, or cases of

the arytenoid cartilages and of the epiglottis is so great that the head of the tube in the larynx is overlapped; hence little relief is experienced. The larynx here requires rest, which it cannot obtain with a large, heavy tube *in situ*.

When called to a case of suffocation, before hastily resorting to intubation one should make a correct



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.

Gradual development of intubation instruments.

retroesophageal abscess, had best, for obvious reasons, be treated otherwise. In many cases there is marked dyspnea from great enlargement of the tonsils and uvula, associated with nasal obstruction, with little or no involvement of the larynx. Intubation would be useless and uncalled for in these cases. Edema of the larynx may give rise to great and even fatal dyspnea. The majority of such cases are better treated by tracheotomy. In most of these cases the swelling of

diagnosis and exclude the cases in which this operation is clearly contraindicated. This matter of differential diagnosis is most important, and a patient's life may depend quite as much upon the diagnostic skill of the physician as upon his ability to do the operation when indicated. The special field and usefulness of intubation is in cases of diphtheritic or membranous obstruction of the larynx, in laryngeal growths in children, and in cicatricial stenosis in the adult.

It is unnecessary in this connection to review the literature of intubation in cases of papilloma in children or of cicatricial stenosis in the adult. It is a legitimate and often successful procedure in both conditions.

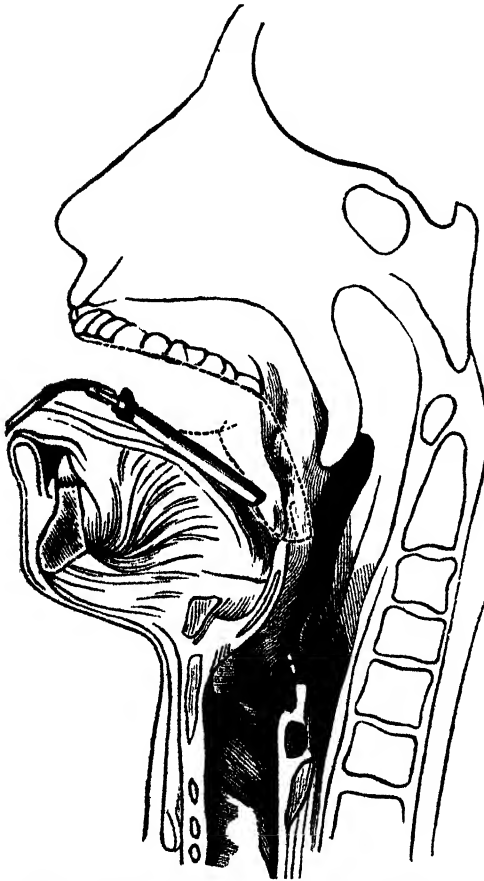


Fig. 8.—Course of the tube from the mouth to the laryngeal cavity.

**INTUBATION IN DIPHTHERIA.**—In the great majority of cases the operation will be called for to relieve the impending suffocation in diphtheritic or so-called membranous croup. Serum treatment has greatly diminished the percentage of intubations, as antitoxin causes the most serious symptoms rapidly to disappear. The main use of intubation at

present, therefore, is *to assist in tiding the patient over momentary peril*. The ratio of cases requiring intubation in hospital practice varies from about 10 to 30 per cent. of the total number. Inasmuch as, properly carried out, the operation in no wise compromises the case or adds to its danger, but gives comfort, relieves suffering, and prevents exhaustion, there seems to be no valid reason why it should be postponed after certain well-marked symptoms have occurred.

When the voice becomes toneless and whispering, and the cough is suppressed; when, in addition, the dyspnea becomes urgent, and the loud stridor of croup is heard both during inspiration and expiration; when there is marked recession at the base of the sternum and above the clavicles; when the pulse begins to fail or becomes intermittent, and when all these symptoms cannot be relieved by emetics, it is certainly time to intubate.

Intubation is preferable to tracheotomy, as it causes little trauma, leaves no scar, is less conducive to pneumonia, and is eminently better if done in the home where light and facilities for sterilization are poor. Extubation should not be done for at least 5 days, allowing time for the antitoxin to dissolve the membrane completely. Mauldin (Jour. So. Carol. Med. Assoc., Feb., 1924).

While one is not justified in waiting longer after these symptoms have appeared, it is even better when possible to operate earlier. When the diagnosis is positive, as indicated by the voice and cough, beginning dyspnea, the bacteriological examination, and gradually increasing distress in spite of treatment, one should not wait until the condition becomes alarming. In infants and in young and feeble

subjects dyspnea insufficient to give rise to marked cyanosis or alarming symptoms of suffocation may nevertheless be sufficient to cause dangerous or even fatal exhaustion. In these cases it is the physician's duty to operate earlier than when the patients are older, more rugged, and better able to stand the exhaustion caused by difficult respiration.

The temporary cyanosis which comes and goes with the paroxysmal dyspnea of the second stage of croup is of no particular significance. Children seldom remain long in one position when suffering severely from want of breath, and continued restlessness, if consciousness be unimpaired, is therefore an important indication that it is time to afford relief (O'Dwyer).

**TECHNIQUE.—Preliminary Practice.**—Preliminary practice upon the adult cadaver is of but little help in acquiring the operative technique for children. The adult larynx, in the cadaver, is almost beyond the reach of the finger; the epiglottis is prominent, while the cavity of the larynx is large and easily determined. In young children, however, the epiglottis is small, while the rima glottidis feels to the touch as a mere slit or depression. By referring to Fig. 8 it will be seen that, if the epiglottis is drawn forward with the finger and the tube is passed in the median line with its point hugging the anterior wall, it must necessarily pass into the larynx. It is important to follow precisely the median line and to hug the anterior wall with the point of the tube.

Some operators prefer to perform the operation in the adult by the aid of the laryngeal mirror. The patient holds the tongue (with a napkin or

soft towel between the thumb and forefinger of the right hand) well drawn out, while the operator, sitting in front and aided by reflected light from a mirror on the forehead and by the laryngeal mirror, guides the tube over the epiglottis and engages its

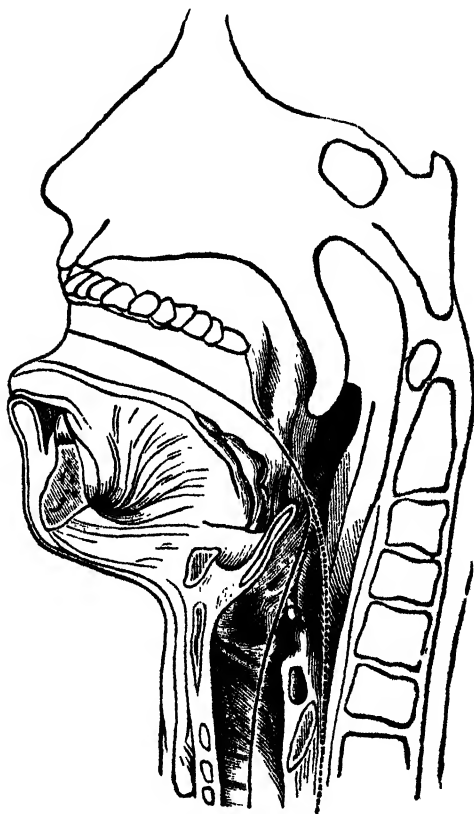


Fig. 9.

point in the cavity of the larynx. Quickly dropping the laryngeal mirror from the left hand, he then passes the forefinger down upon the head of the tube and crowds it into position. One accustomed to laryngeal work will perform the operation in this manner very readily, but the procedure is practically impossible for one not familiar with laryngeal instruments and their use.

Intubation in children by this method is impracticable. The patient must be properly held before a good light. The base of the tongue is held down with a tongue-depressor and, as the epiglottis rises to view, the point of the tube is directed into the larynx,

ferred; but it may be employed by those who do not possess or who cannot acquire the manual dexterity to perform the operation with the assistance of the tactile sense alone, *i.e.*, unaided by the eye.

The ideal operation should be con-

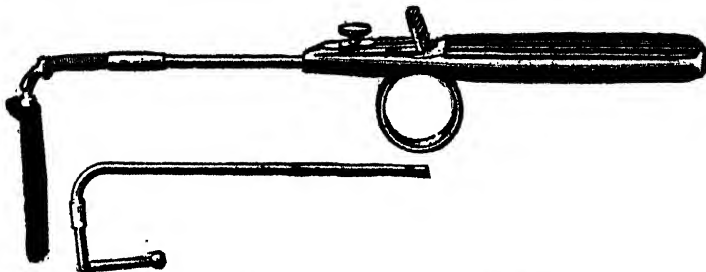


Fig. 10.—Introducer with tube and detached obturator.

passing immediately behind the epiglottis. The tube is then pressed down into position with the forefinger of the left hand as the tube is released from its introducer. As soon as the point of the tube passes over the epiglottis, the hand holding the intro-

duced through the sense of touch entirely. One should handle the instruments frequently; the sliding spring of the introducer, shown in the cut, should be moved by the thumb and not by the forefinger. The extractor should be held in the manner indi-

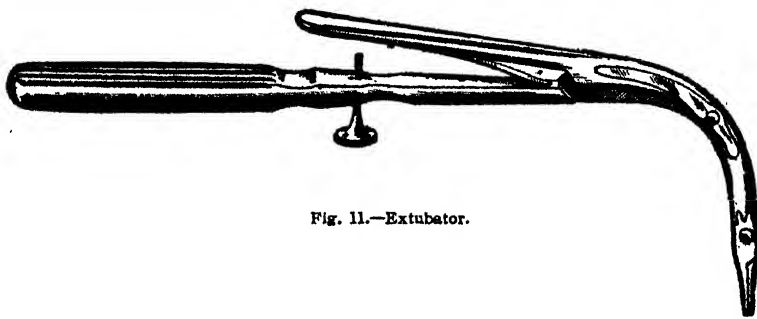


Fig. 11.—Extubator.

ducer must be quickly elevated, keeping the point of the tube stationary until the turn is made, in order that the tube may pass down at an acute angle. Otherwise the tube will invariably slide over into the esophagus. Figure 9 shows how such a misdirection can be given the tube. This method is not that to be pre-

pared by the second figure. By frequently introducing the tube into the closed hand of another person, holding the introducer in the right hand, detaching the tube and pressing down with the forefinger of the left hand in the exact manner as when introduced into the larynx, slight practical experience can be gained. Or

should become so familiar with the instruments that the various steps of the operation can be carried out, so to say, automatically.

As the extraction of the tube is even more difficult than its introduction, it is important also to practice

when the end of the tube reaches the larynx, and before it becomes engaged, spasm of the larynx occurs. In such a case it is best, instead of using force, simply to wait a few seconds, holding the tube in position. The patient will then endeavor to



Fig. 12.—Intubation. Second step in operation: Handle of introducer elevated, the tube sinking into larynx as the handle of introducer is elevated. (Fischer.)

extracting it from the closed hand of another. Introducing and extracting the tube from the larynx of a small dog under an anesthetic will frequently be of great help in acquiring dexterity.

The instruments should be held lightly. Little or no force should be used, no anesthetic is necessary, and the operation should not require a longer time than from five to ten seconds. It occasionally happens that

when the end of the tube reaches the larynx, and before it becomes engaged, spasm of the larynx occurs. In such a case it is best, instead of using force, simply to wait a few seconds, holding the tube in position. The patient will then endeavor to

breath, the spasm will relax, and the tube will drop into position. The operator is exposed to infection through injury, previously broken skin, and explosive cough. To avoid the first, a piece of adhesive strip may be placed over the second or third joint of the left index finger, reaching well up the back of the hand. This will obviate injury from contact with teeth in reaching down the throat to raise the epiglottis. Infection through previously broken skin—cuts, scratches, etc., probably forgot-



ten—may be avoided by placing the hand in ammonia water. Such injuries will be forcibly brought to the operator's attention and collodion may be applied or a finger cot worn. To protect the eyes, ordinary spectacles may be worn. G. F. Cott (*Laryngoscope*, Feb., 1905).

In performing the operation the physician should first select a tube appropriate for the age of the patient, as indicated by a scale that accompanies every set of instruments. The tube should then be threaded with silk or linen thread, making a loop about 14 inches in length. The obturator fitting the tube to be used (Fig. 7) should then be screwed upon the introducer if the O'Dwyer instruments are used, and the tube attached. It is now ready for use, and should be placed upon the table within easy reach. The patient is frequently held upright in the lap of the nurse, supported closely against the left chest with the head resting on the shoulder. Another plan, in many instances more convenient, especially where there are no trained assistants, is to wrap the child firmly, all but the head, in a blanket, and place him flat on his back on a table ("dorsal method"). The nurse, if one be available, has merely to hold the child's head still and keep the gag in place (Fig. 12).

The modern method of intubation is the dorsal method, which is easiest in an emergency, because the physician can intubate without many assistants. The introducer should always be held lightly between the thumb and forefinger. Upon repeated forcible attempts at intubation one may enter the ventricles of the larynx, producing a false passage. In such event it is wiser to resort to tracheotomy than to run the danger incident to exhaustion.

**Strychnine** should be very liberally

prescribed from the beginning of the illness. A child several years old can frequently take  $\frac{1}{60}$  grain (0.0013 Gm.) three times a day and oftener to advantage.

Recurring laryngeal stenosis after intubation is usually caused by forcibly pushing the tube into an edematous or infiltrated mucous membrane. The only safeguard in preventing excessive mechanical injury is to introduce a tube of small caliber.

It is a wise rule to remove the tube every five days. Where a tube must be introduced more than twice, the writer adopts the following plan, mentioned by O'Dwyer: Taking a rubber tube, immerse it in a solution of **hot gelatin** containing 25 per cent. of **powdered alum**; introduce the tube with this covering of alum gelatin. The author has also had success with 20 per cent. solution of **ichthyol gelatin**. In the same manner a film consisting of **hot paraffin** and **iodoform** or **europen**, 3 per cent., was applied in another case with very good results. This intralaryngeal medication of the ulcer by means of the intubation tube proved of value in severe cases.

Where an unskilled operator must intubate, a hypodermic injection of  $\frac{1}{100}$  grain (0.00065 Gm.) **strychnine** or  $\frac{1}{2}$  grain (0.032 Gm.) **caffeine sodium benzoate** may be given prior to the operation. It is also wise to have a **mustard foot bath** ready in case of collapse. If the circulation does not improve after this foot bath, given at 100° F., a **hot saline colon flushing** at 115° to 120° F. may be administered. Louis Fischer (*N. Y. Med. Jour.*, Aug. 1, 1908).

If the older, upright, position be employed, the nurse should sit upright in a straight-backed chair and the patient be held firmly and not allowed to slide down. The forearms of the child should be crossed in front and the nurse should grasp the wrists, the left wrist with her right hand and the right wrist with her left

hand. The gag is then introduced in the left angle of the mouth well back between the teeth and widely opened. The operator, standing in front, then quickly seizes the introducer with tube attached, hooks the loop or bridle over the little finger of the left hand, and introduces the index finger of the same hand, closely followed by the tube. He raises the epiglottis forward with the index finger (Fig. 8) and guides the end of the tube gently over it, when, by making an abrupt turn, he will pass the tube into the larynx if he has been careful to keep in the median line; or he may pass the index finger over the epiglottis and upon the arytenoid cartilages and guide the end of the tube into the larynx.

A method advocated by some is to feel for the small opening or depression just back of the epiglottis with the finger and guide the end of the tube into it. In any case the end of the tube should pass under the tip of the finger, not over it or by the side of it, but directly under it. The moment the end of the tube engages the larynx, the right hand, holding the introducer, should be quickly elevated, allowing the tube to pass down at a right angle. Simultaneously the tube is loosened from the introducer by pressing forward the slide with the thumb. The index finger of the left hand, which has acted as guide, is placed upon the head of the tube and gently presses it down into position as the introducer is removed. It is important to bear in mind the necessity of hugging the anterior wall with the end of the tube as it is introduced. In order to do this, it should follow a gentle curve, until it has passed over the epiglottis, and remain stationary

for an instant as far as downward progress is concerned, while the handle is quickly elevated. The dark line in Fig. 13 represents the curve that should be followed by the end of the tube while it is being introduced. This sudden turn constitutes one of the salient points of the operation, for if the curve be continued as indicated by the dotted line the tube will invariably pass into the esophagus.

A prolonged attempt at introducing the tube should be avoided. Many brief trials characterized by gentleness will do much less harm. If during the first attempt the tube passes into the esophagus, the instrument and the finger should be removed from the throat and the patient allowed to recover his breath for a moment. A new trial is then made. Entrance of the tube into the larynx is indicated by violent coughing and by easy respiration, if the tube is not blocked by membrane below it.

To ascertain whether the tube is in position the child, sitting upright, is allowed to drink a small quantity of water from a glass; if the tube is in the larynx violent coughing will result. If it is in the esophagus there will be no violent coughing, no relief from the threatening suffocation, and there will also be a gradual shortening of the loop as the tube gravitates toward the stomach.

If the operator is quite certain that the tube has entered the larynx, the gag should be removed and the loop placed backward over the ear. While doing this, the hands of the patient should be held firmly by the nurse; otherwise the child will grasp the thread, pull out the tube, and the procedure will have to be repeated. The

operator should wait a few minutes to make sure that the tube is in position, and to allow the cough to expel the mucus and softened membrane. He should then replace the gag, cut the loop near the mouth, and introduce the index finger of the left hand until it reaches the head of the tube. This is held down while the thread is removed by pulling on one end of the loop.

In the author's experience with intubation the difficulties generally described in connection with it have been practically non-existent. He finds that in nearly all cases, when the tube has been coughed out, if the dyspnea returns it does so very gradually, giving abundant opportunity for replacement. It has been taught that the intubated child must be fed with the head low, but the children seem to get along very well in any position and to be able to eat or drink anything after they become accustomed to the situation. Restraint beyond keeping the child in bed is unnecessary, except as it may be needed for the diphtheria. After the tube is in its proper place the string should be removed, as its presence excites coughing. Occasionally, upon extubation, the tube must be replaced to relieve a sharp attack of dyspnea; therefore it is well after extubation for the operator to remain with the patient for an hour. C. W. Berry (*Long Isl. Med. Jour.*, Dec., 1922).

In the removal of a tube which has lodged in the nasopharynx, the tube may slip from the fingers and be swallowed, but this should give no cause for alarm, as it will pass on through the gastrointestinal tract. The authors have known instances in which as many as 3 tubes were in the intestines at one time and all passed without any inconvenience. It is difficult to remove a tube that has a tendency to slip down the larynx. One must be able to recognize this condition early, or the tube will get

out of reach of the direct extubator. If, in inserting the extubator, the tube moves before it can be grasped, it is best to abandon that method and use a bent wire. If the tube gets down into a bronchus, tracheotomy for its removal is indicated. E. Giddings and D. E. Ehrlich (*Laryngosc.*, June, 1923).

If, in introducing the tube, membrane is crowded down ahead of it and respiration is difficult or impossible as a consequence, the patient should be encouraged to cough violently.

As the patient does this the tube should be quickly jerked by means of the thread still attached, or the tube may be entirely removed by extubation. Frequently a large mass of membrane will be expelled. If this does not occur, stimulants and water should be given and violent coughing encouraged.

It will occasionally happen that in spite of all efforts a patient is unable to expel the offending and obstructing membrane. In such a case it is necessary to employ a long pair of tracheal forceps and, as the child coughs, endeavor to grasp the membrane and remove it. If one is still unsuccessful, the last resort is to perform tracheotomy and extract the membrane. This, however, is rarely necessary.

Of 498 intubation cases in v. Bokay's series, an immediate tracheotomy became necessary in  $3\frac{1}{2}$  per cent. Tracheotomy failed to relieve the asphyxia in only 2 of these cases, and these patients died from the pushing down of false membrane.

Pushing down membrane in advance of the tube is likely to happen to any one at any time, but fatal results are infrequent. With its prompt recognition the danger is met

by immediate withdrawal of the tube by its string. With the head already lowered (in the dorsal method), the loosened membrane is driven out by the expulsive cough, and with it probably all further need of a reintroduction removed.

There is occasional difficulty in hooking forward an epiglottis folded upon itself or shortened by its inherent power of contraction; gentle traction on the base of the tongue with the armed obturator has often successfully served the author in such cases. Faulty manipulation completely occluding the air passages may induce a laryngeal spasm; upon withdrawing the obturator as soon as the end of the tube engages in the larynx and allowing air to enter, this spasm will relax. Should it, however, refuse to yield, it is only necessary to steady the tube by gentle digital pressure on its head until the next inspiratory effort invites its gliding into its bed.

Aiming to minimize the risk of pressure sores, the author ordinarily removes the tube in three or four days, particularly when gradual disappearance of visible exudate and general healthier aspect of tonsils and pharynx encourage the trial. Vulcanized tubes are longer tolerated than the metallic, which require more frequent cleansing of their irritating lime-salt deposits.

When an operator, in the effort to extubate, has pushed the tube beyond digital reach and is confronted by alarming symptoms of a supratubal edema external manipulation will frequently succeed in stripping the tube to within reach of the extractor and thus avoid tracheotomy. Lee Kahn (*Amer. Pract. and News*, April, 1911).

If the child is not too far from the physician in charge and an intelligent person can be secured and taught how to remove the tube instantly in case it becomes occluded, the child may remain in the home, but, as a general rule, swift removal to an institution is safer. A stay of three to five days is generally all that is required. The string from the

tube can be given sufficient slack in the mouth, then pulled upon the child's cheek, and there fastened with a bit of adhesive plaster. Under no circumstances should the string be removed till the tube comes with it. The child in a few hours becomes accustomed to the string as well as the tube and does not care for it. In case the tube becomes suddenly stopped up by membrane or thick mucus, the most skilled operator cannot remove the tube quick enough to prevent strangulation, whereas if the string is left in, the nurse can instantly remove it. The child must be kept continually bound in a sheet so as to prevent its getting hold of the

Fig. 13.

string. The resulting inconvenience is more than outweighed in the safety which it promises. The nurse should three or four times a day introduce her finger and feel for the tube in the larynx. It should barely be felt, and in case it be prominent between the vocal cords she should gently push it down.

As a rule, the tube should not be taken out for twenty-four hours after the symptoms have vanished. If it does not have to be replaced in four hours, it can usually be dispensed with. Hoarseness often remains for several weeks after intubation. J. J. Waller (*So. Med. Jour.*, Oct., 1912).

After the tube has been successfully introduced the patient experiences entire relief. The change in the appearance of the patient is not only immediate, but remarkable. The loud stridor, sometimes heard all over the

house; the projecting eyeballs, the livid features, the cyanosis, the clutching at the throat, the piteous begging in a whispering voice for help, cease as if by magic. The patient lies pale and quiet. The loud stridor is replaced by almost noiseless respiration, and the patient falls into quiet, refreshing slumber.

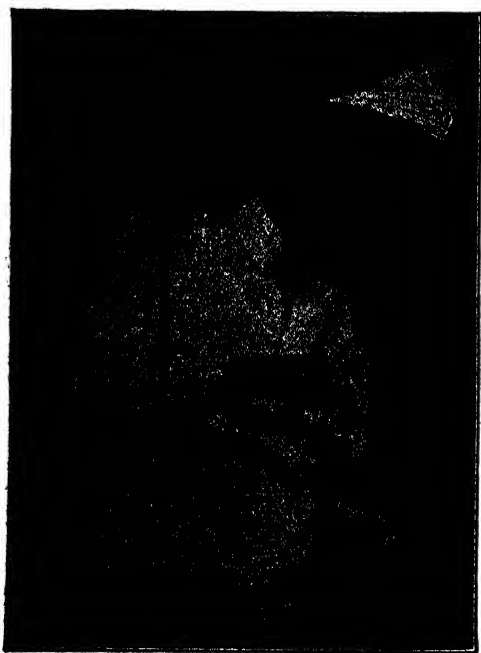


Fig. 14.—Casselberry method of feeding. (Fischer.)

**AFTER-TREATMENT OF INTUBATED CASES.**—Rest and nutrition are now important. In the early days of intubation, the question of feeding was beset with many difficulties, but later these obstacles were largely overcome. It was found by Carey and Casselberry, of Chicago, while jointly treating a case, that if the patient was placed in the recumbent position, with the head slightly lower than the shoulders, swallowing could be effected with little difficulty. This discovery marked a great ad-

vance in the successful management of these cases, and added not a little to the success of the operation and to the comfort of the little sufferers.

The mechanism is simple enough: The intubation tube being inclined, with the proximal end lower than the distal, the fluid cannot drop into it. The patient should be placed on a pillow with the head extending slightly over it, either on the back or the side, preferably the side; the pillow is moved over the side of the bed and the head slightly depressed (Fig. 14). If the head is lowered too much the fluid will pass into the post-nasal space and nasal cavities, while if it is raised too much it will pass through the tube and into the lungs and cause violent coughing. A few trials will demonstrate the required position in each individual case. With a little patience and firmness a child should take an abundance of liquid nourishment without difficulty. The physician should himself attend personally to this matter until the attendants are so trained that they are fully capable. Hillis prefers to have the patient lie on the stomach, face down, as this gives him greater command over the constrictors.

It is best to give water and food from a spoon, although some children will prefer to draw it through a glass or rubber tube. The nourishment should be milk, beef-juice, or the various soups, although semisolids—as custards, ice-cream, and the like—may be allowed where there is repugnance for the more fluid foods. Milk is the most convenient and usually the best food that can be given in these cases, though Fischer states that in the older children he invariably administers articles such as

bread soaked in milk, junket, corn-starch or rice pudding, soft-boiled eggs, chicken jelly, etc. Where a breast-fed infant will not nurse, the milk can be obtained by means of a pump and administered with a spoon. If vomiting should occur in intubated cases, rectal alimentation may be availed of.

In feeding the intubated child a glass tube is desirable if the child can be taught to use it, and in most cases it can. If it is inclined to bite the tube a small piece of rubber tubing can be attached for the child's mouth. If the child can not or will not attempt to swallow, gavage is easily carried out. J. J. Waller (*So. Med. Jour.*, Oct., 1912).

Intubated patients may well be fed through a nasal catheter, the food consisting of mixtures of milk with sugar, well-beaten eggs or chocolate. Plenty of food should be given, in small quantities repeated every 3 hours. The writer much prefers this method to that of feeding with a spoon or nursing-bottle. Hot applications are useful after intubation. The tube should generally be removed in 36 to 48 hours. One should not replace expelled tubes with tubes of a larger caliber. Intubation may often be obviated with baths, hot applications, a moist atmosphere and antispasmodics. A. Alcalá y Henke (*Rev. españ. de laring.*, July-Aug., 1924).

Regarding the after-treatment, little need be said. **Antitoxin** should have been given at the very onset of the disease. If not, it should now be given in large dosage, and repeated in twelve or sixteen hours, if this seems advisable. If there is a tendency of the membrane to extend downward, as indicated by quickened respiration and sometimes by râles or roughened or harsh respiratory sounds, then the antitoxin should be crowded to the limit.

### OBSTRUCTION OF TUBE.—

The attendants should be instructed in case of emergency, if obstruction occurs suddenly, to hold the child with the head down, shaking him while another suddenly and sharply strikes the patient a smart blow upon the chest and back.

In case total obstruction occurs the child will die in a few moments unless the tube can be expelled. Happily, these emergencies do not frequently occur. If everything goes smoothly, the patient is taking nourishment well, and there has occurred no evidence of obstruction, it is our custom to remove the tube on the fourth or fifth day. It will very seldom happen that the tube will be necessary for a longer time, providing the operation has been skillfully performed and no damage done to the pharynx. The shorter the time the tube is worn, the less likely is one to meet with paralysis of the vocal cords and other conditions that often require its long-continued use.

**EXTRACTION OF TUBE.**—The patient should be placed in the same position as for introduction. The gag should be placed as before and the index finger of the left hand introduced until it reaches the head of the tube. The extubator, the point of which should be guided into the tube, is held in the right hand, and should quickly follow the finger (Fig. 15). By pressing on the lever above the handle the jaws of the instrument are separated, thus holding the tube securely while it is removed.

The irritation from removal of an intubation tube sometimes causes laryngeal spasm, with excessive secretion of mucus, rendering it necessary to reintroduce the tube, which is

often very difficult. The spasm and mucous secretion can be obviated by administering a dose of **atropine sulphate** fifteen to twenty minutes before removal. The author never practises instrumental removal, finding it easier, quicker, and safer to

3 hours for 4 doses, or 10 grain (0.6 Gm.) doses of **sodium bromide**, with 2 grains (0.12 Gm.) of **chloral hydrate**, repeated in 6 hours, will have a quieting effect. Antispasmodics are continued for 24 hours after extubation. L. Fischer ("Diseases of Infancy and Childhood," 9th Ed., 1923).

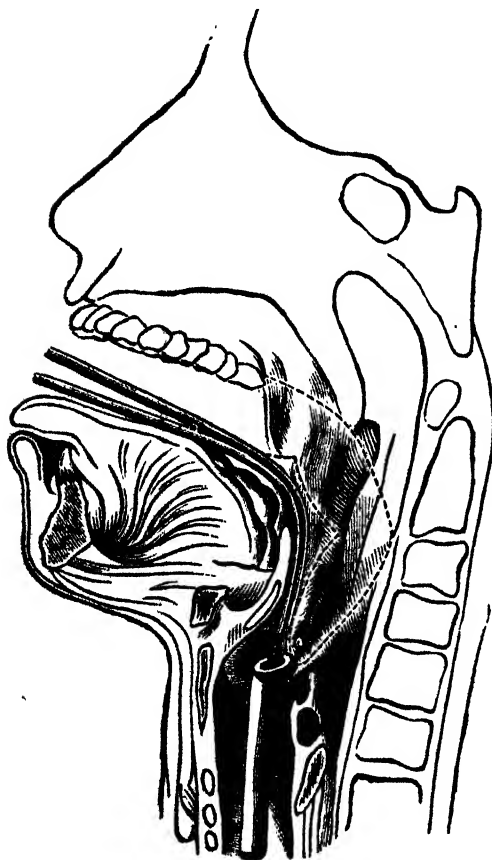


Fig. 15.

remove the tube by exerting slight pressure backward and upward below the tube on the trachea. The patient then gags, when the tube can be easily grasped with forceps or fingers. Lewis (Va. Med. Semi-Monthly, March 27, 1908).

The nervous, frightened child must be quieted before extubation. The writer usually orders an antispasmodic 12 hours beforehand. **Codeine**,  $\frac{1}{4}$  or  $\frac{1}{2}$  grain (0.015 or 0.02 Gm.) to a child of 2 years or older, is repeated every

If the case is not one of mixed infection, all sprays and douches and applications to the throat can be abandoned. In case of *mixed infection*, if there is much offensive discharge from the nose and throat, a simple **non-irritating antiseptic solution** should be gently used in the nasal cavities with the douche or syringe and in the throat by means of the spray, **antitoxin** being given at the same time and the patient supported by **stimulants** and **nourishment**.

*How long should the tube be allowed to remain in the larynx?* This will depend entirely upon circumstances. If there is a considerable amount of membrane in the trachea it must necessarily come away; sometimes it softens down and is expelled through the tube in the form of mucus without difficulty, but not infrequently large flakes or patches become loosened and endanger the life of the patient by obstructing the tube. If a too tightly fitting tube has not been used it will frequently be expelled on the second or third day on account of obstructing membrane below it, and commonly it will not be necessary to replace it. It is always to be feared, however, that the tube may not be expelled when it becomes obstructed. Whenever there is evidence of partially detached membrane below the tube indicated by a flapping sound, a peculiar hoarseness of the cough, or by sudden and evident

closure of tube during an expulsive cough, one should at once extract the tube, whether it has been in one day, three days, or four days, or else remain constantly with the patient in order to extract the tube in case total obstruction occurs and the patient is unable to expel it.

Case of false passage in intubation, with complete perforation of the larynx. Cricotracheotomy was at once carried out, with permanent recovery. Impeded breathing or asphyxia after intubation should suggest this accident; likewise, an oblique position of the tube, hemorrhage and subcutaneous emphysema. It may be due to obstruction from spasm, excessive haste and force, or raising the handle of the instrument unduly. C. von Ujj (*Jahrb. f. Kind.*, Oct., 1922).

In a child of 3 years, expulsion of the tube after intubation for laryngitis complicating measles was followed by asphyxia and cardiac arrest before the tube could be reinserted. After 15 minutes spent in vain treatment by tracheotomy and artificial respiration, an intracardiac injection of 1 c.c. (16 minims) of adrenalin solution was given. Vigorous heart action and respiration followed, but the child died in 22 hours. Lereboullet, Lelong and Courmand (*Bull. Soc. de péd. de Paris*, June-July, 1924).

Trumpp found, in a case in which attempts at extraction had caused a small tube to sink farther down into the larynx, that pressure with the thumb on the trachea, just below the cricoid cartilage, where the end of the tube could be felt, caused cough, which forced the tube out. This method of expression never failed in his subsequent cases. The pressure may be made with both thumbs inward and directly upward. If strong pressure is exerted the tube may be forced entirely out of the mouth.

While it is the rule that the tube is

no longer necessary after the fourth or fifth day, and frequently not after the second or third, yet it sometimes occurs that it cannot be dispensed with for two, three, or six weeks, or even longer. After its removal the dyspnea returns, sometimes immediately, sometimes after a few hours, and occasionally after one or two days have passed.

It is always well to remain with the patient an hour after the removal of the tube or be within ready call in order to replace the tube in case of emergency. Cases of sudden death have occurred from returning dyspnea after the operation has left the patient in fancied security. As a rule, the dyspnea returns slowly; so that it is several hours before the patient is in an alarming condition. Occasionally it returns suddenly and almost immediately after the removal of the tube. Labored breathing and a sudden increase in the respiratory or pulse rate are the danger signals.

#### PROLONGED USE OF TUBE.

—A number of causes have been enumerated as rendering necessary the long-continued use of the tube. Principal among them may be mentioned the formation of diphtheritic exudate or its long persistence in the larynx and trachea; edema of the tissues; ulceration of the cricoid cartilage and consequent collapse of the thyroid cartilage; cicatricial contractions and exuberant granulations following ulcerations, and abduction paralysis.

According to Rogers and Köhl, the commonest cause of postdiphtheritic stenosis necessitating prolonged use of a tube is a hypertrophy of the subglottic tissues, with chronic inflammation. Neither this, however, nor the less frequently occurring ulceration,



followed by cicatricial tissue and contraction, is due directly to the intubation, except in rare, unavoidable instances. Rogers holds, moreover, that exuberant granulations do not occur with intubation, no matter how prolonged. Fischer thinks rachitic children are predisposed to laryngeal stenosis as a result of diphtheria.

O'Dwyer and many others have held, however, that some of the lesions observed are due to a too tightly fitting tube, to leaving the tube in too long, to poorly constructed instruments, and some to injuries resulting from unskilled operations. With the use of antitoxin, which enables the patient to dispense with the tube at an earlier date, and great skill acquired in performing the operation, these conditions would then, of course, less frequently arise.

An important point is that when the operator appreciates the fact that a tube is too large, as indicated by the force required to press it down into position, he should at once remove it and use a smaller one. The unduly large one might not only cause ulceration or paralysis from undue pressure, but, in case of obstruction below the tube, also give rise to exfoliation of membrane. There would, furthermore, be danger of sudden suffocation from the inability of the patient to expel the tube.

Since the tube, while in the larynx, moves with each swallow, cry, or even respiration of the patient unless it is of the proper shape and size, serious lesions in the larynx are apt to occur. Decubitus sores, as such injuries are called, are usually situated (1) on the anterior wall of the trachea below the cricoid, due to pressure of the lower end of the tube; (2) above the cricoid over the lateral and anterior surface of the larynx, due to pressure of the

retention swell, or (3) on the under surfaces of the epiglottis, due to pressure from the head of the tube. The most important of these is the decubitus above the cricoid laterally and in front, for here enter on both sides the recurrent laryngeal nerves and it is urged that it is pressure paralysis of the nerves which gives rise to the third group of cases, characterized by repeated coughing up of the tubes. Most of these injuries are due to the use of unskillful modifications of the O'Dwyer tube. When the vocal cords are paralyzed as a result of pressure on the nerves the tube loses one of its most important means of retention, for the cords do not form a constriction above the retention swell. H. W. E. Berg (*Med. Rec.*, Aug. 1, 1903).

In case there is long-continued necessity for the use of the tube—as occurs in about 1 per cent. of all intubated patients (Duel)—what can be done? After removing the tube on the fourth or fifth day, if the dyspnea returns, a smaller tube should be introduced instead of the one removed. This in turn should not remain longer than two days without being removed, providing it has not been previously expelled. If the dyspnea still returns, introduce a still smaller tube. The effort should now be to use the smallest tube that will be retained. This method, together with the free administration of *strychnine*, offers the greatest hope of promptly overcoming the difficulty (Waxham).

Since, in prolonged cases of intubation, autoextubation is common, and an element of danger is thus introduced when no experienced intubator is constantly on hand, many such cases are subjected to tracheotomy, for greater safety. After high tracheotomy, however, cicatricial bands are almost certain to form in the tra-

chea or lower portion of the larynx above the tracheotomy (Duel). It may, therefore, become necessary to dilate the involved canal by the insertion of progressively larger tubes, under anesthesia. Fischer advises that a large special tube, with the constriction below its neck only  $\frac{1}{32}$  inch smaller than the retaining swell, be then left in undisturbed for at least six weeks. If a cure has not been accomplished at the end of this period, it can be replaced.

Prolonged intubation often gives rise to the formation of ulcers in the cricoid region, provoking edema below the glottis and laryngeal spasm. Here the writer uses a thick paste of alum, starch, water, and a little glycerin applied freely to the tube, which is then allowed to dry a few hours and inserted. The alum acts very satisfactorily on the ulcerations. The alum coated tube is recommended whenever intubation exceeds 150 hours or the tube upon removal shows black or white spots indicative of ulceration. H. Mallet (*Revue méd. de la Suisse rom., Aug., 1915*).

Intralaryngeal medication in cases of *recurring stenosis* has been warmly advocated. Many observers have used the intubation tube itself with advantage as a carrier of local remedies. Thus, Fischer, for a child 2 years old, has a 1-year-sized tube coated with a jelly made up of shredded French gelatin and glycerin, of each, 2 parts; ichthyol, 1 part, and water, 10 parts. This is melted on a water-bath, and the tube dipped into it and allowed to dry. Excess of gelatin coating can be made to drip off by steaming the tube.

Case of postoperative perichondritis of the larynx in which, for the increasing dyspnea, tracheotomy was required. Gradual dilatation with Schrötter's tubes was practised for

about a month, followed by intubation, the tube being worn for periods of 6 weeks and 6 months, with recovery.

In another case, with papilloma of the larynx, operation was followed by tracheotomy, and, later, unsuccessful attempts were made to have the patient wear a large-sized hard-rubber intubation tube, which was soon coughed out. Finally, a metal intubation tube with the Rogers attachment (a screw-piece attachment introduced through the tracheotomy wound) was introduced, and this was kept in position for four weeks. Some small pieces of granulation tissue were removed endolaryngeally, and the patient was discharged as cured, with a hoarse, but fairly loud voice. E. Mayer (*Med. Rec., Dec. 25, 1909*).

The following indications and rules for intubation in chronic laryngeal stenosis endorsed, as originally laid down by O'Dwyer: (1) Cicatricial stenosis, due to injury to the soft parts from syphilis, irritants and traumatism. (2) Narrowing of the space both below and above the vocal bands from the products of chronic inflammation—simple, tuberculous, specific, malignant or otherwise, and including "pachydermia laryngis" and corditis vocalis inferior hypertrophica. (3) It is especially valuable in tracheotomized cases when, the tracheal cannula having been worn for a considerable time, the upper part of the trachea is filled with granulations and the laryngeal muscles have become weakened from disease. In this condition intubation has effected many brilliant cures. (4) In papilloma of the larynx it has been found helpful in a fair proportion of cases, though less satisfactory than in most other conditions in which it has been employed. (5) Deformity of the larynx from injury or disease of its cartilaginous framework, with constriction of the caliber of the organ, have been cured by it. (6) Excellent results have also been obtained in ankylosis and in arthritis deformans of the crico-arytenoid articulations. (7) It is useful in various affections of the nerves of

the larynx, *e.g.*, in hysterical contraction of the abductors, "aphonia spastica." L. Fischer ("Diseases of Infancy and Childhood," 9th Ed., 1923).

**MODIFICATIONS OF O'DWYER'S INSTRUMENTS.**—The instruments, as fully perfected by O'Dwyer, have been modified by various operators; some of these modifications are questionable improvements, while some undoubtedly

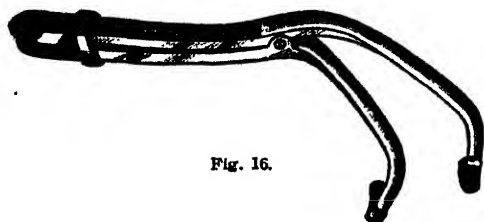


Fig. 16.

possess advantages. The main idea, however, remains unchanged, and, however greatly the instruments may be altered, the fame of the original inventor will never be dimmed. In this connection reference will be made to only a few of these modifications.

One of the writers (Waxham), in the early history of the operation, finding the original gag (Fig. 16) inconvenient on account of its striking the shoulder, had one constructed (Fig. 18) to extend backward instead of downward, thus overcoming this objection. This gag answers well all requirements. The gag has also been modified by others, notably by Henriotin (Fig. 17) and Allingham (Fig. 19). An ingenious method of overcoming the difficulty of extracting the tube was devised by Dillon Brown. It consists of a tube, with small ring attached to the head, and a thimble, with hook attached, which he used on the index finger of the right hand. Another modification has been devised by Ferroud, aiming to make one

instrument answer for both extractor and introducer; his instruments have been still further modified and simplified.

A number of years ago, one of the writers (Waxham) devised a set of instruments differing in many particulars from those of O'Dwyer, the dominant idea, however, being the same. The aim was to insure more perfect disinfection. The obturator has no joint and is not screwed upon the instrument, but is a plain band of steel solidly attached to the introducer. Moreover, the instrument, which consists of only two plain pieces of metal, can be easily separated. There are no crevices in which septic matter can be concealed. The tubes are the same as in the O'Dwyer set. The gag is constructed so as to insure unlocking of the blades for purposes of disinfection. The ex-



Fig. 17.

tractor (Fig. 20) is also so constructed that the three parts of which it is made can easily be separated for the same purpose. These instruments are simple and efficient.

Thorner has designed an instrument which combines the offices of extractor and introducer. It has at its distal extremity two serrated beaks about 2 inches long (Fig. 21). They

are opened by pressure with the thumb upon a lever, and are automatically held open by a ratchet arrangement, while pressure with the index finger upon the lower end of this ratchet-bar relieves it and closes

clining from right to left. This facilitates the passage of the tube between the vocal cords.

**COMPARATIVE VALUE OF INTUBATION.**—The weight of evidence in favor of intubation, as com-

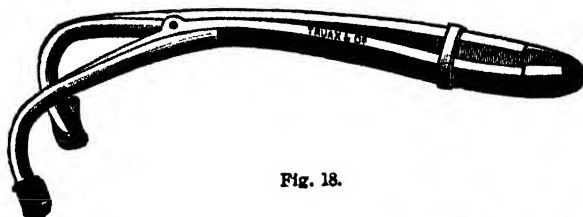


Fig. 18.

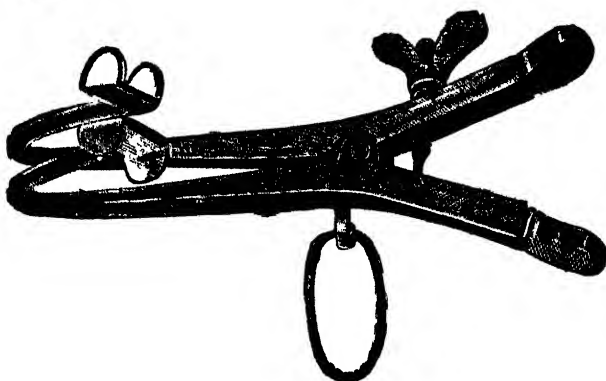


Fig. 19.

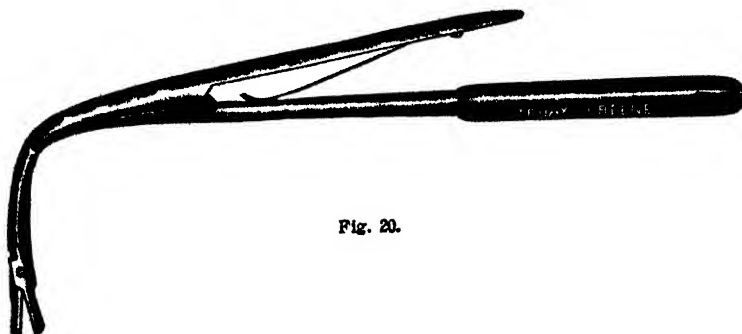


Fig. 20.

the beaks. By firm pressure the beaks hold the tube immovably. The tubes themselves are also slightly modified, the upper opening being funnel-shaped to facilitate the introduction of the beaks when the tube is in the larynx, and the lower end being cut off at an angle of 45 degrees, in-

pared to that favoring tracheotomy, leaves the advantage with intubation as a life-saving operation. Out of 543 cases in which one of the authors performed intubation, all in private practice, he obtained 215 recoveries, or 39.79 per cent. In the last series of 143 cases, there were 76 recoveries, or

53.14 per cent. In 40 cases in which antitoxin was employed in conjunction with intubation, there were 38 recoveries, or 95 per cent. Of 1204 cases intubated at the Willard Parker Hospital, New York, in the years 1915 to 1920, inclusive, 58 per cent. recovered. The percentage of com-

frequently when marked tonsillar hypertrophy exists; pathological adenoids and tonsils are prominent predisposing factors in this condition. \* Laryngeal paralysis after intubation is extremely rare.

If a patient dies after intubation from bronchial obstruction due to the presence of diphtheritic exudation,

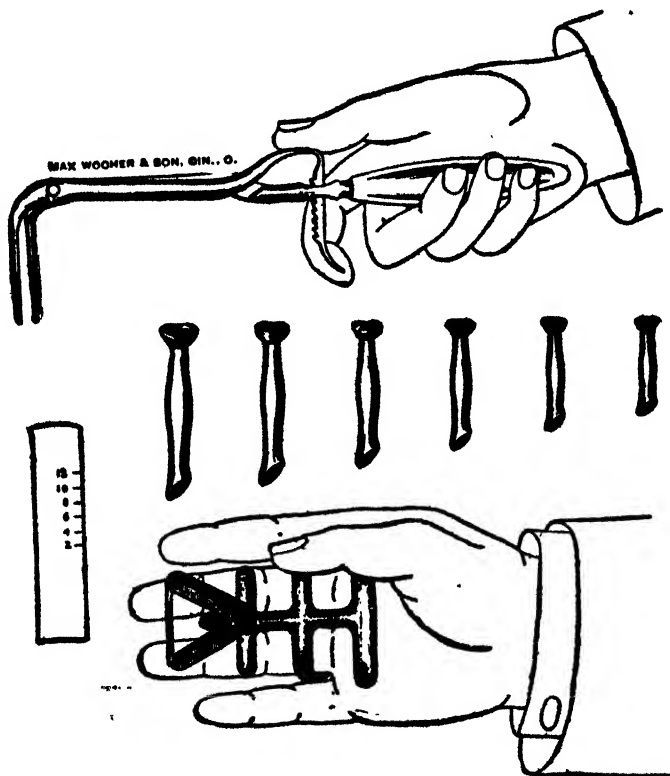


Fig. 21.—Thorner's combined introducer and extractor.

plicating pneumonia was 3.5 in 1919 and 5.9 in 1920.

Among 437 intubations for laryngeal diphtheria analyzed by Shurly, 80 per cent. of the patients were alive when the tube was removed. Among 30 of the older children subsequently examined, the time during which the tube had been worn consecutively was from 48 to 124 hours. Intubation in laryngeal diphtheria is required more

antitoxin has either been used late, the extension having taken place before its administration, or has been used with a hesitating hand and in insufficient dosage.

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AND

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